THE UNIVERSITY OF KANSAS
PALEONTOLOGICAL CONTRIBUTIONS

ARTICLE 54 (COELENTERATA 4)

DISSEPIMENTAL RUGOSE CORALS OF UPPER PENNSYLVANIAN (MISSOURIAN) ROCKS OF KANSAS

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THE UNIVERSITY OF KANSAS PUBLICATIONS
OCTOBER 13, 1970

THE UNIVERSITY OF KANSAS PALEONTOLOGICAL CONTRIBUTIONS
Article 54 (Coelenterata 4), 67 Pages, 11 Figures, 8 Plates, 6 Tables

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ABSTRACT

Upper Pennsylvanian Missourian rocks of Kansas consist of alternating limestone and shale formations. Each limestone formation is divided into 1) a normal facies belt of thin limestones generally containing abundant invertebrates and few phylloid algae, and 2) at least one phylloid algal mound complex belt which is considerably thicker than the normal belt limestones and contains diverse algae and limestone types. The southern extent of all Missourian limestone formations except the Drum is marked by development of these features.

Twenty-six species of dissepimental corals belonging to *Dibunophyllum, Neokoninckophyllum, Caninia,* and *Geyerophyllum* are described from both carbonate facies belts but not from thick shale formations.

Family Aulophyllidae is represented by 17 species of *Dibunophyllum* and *Neokoninckophyllum,* the former containing *D. valeriae, D. parvum,* and five new species here described and the latter containing *N. tushanense, N. kansasense,* and six new species. Family Cyathopsidae is represented by the long-ranging species *Caninia torquia* and a new species. Seven species (five new) here referred to *Geyerophyllum* are placed in Family Geyerophyllidae.

Four distinct faunal zones are recognized, three in the Kansas City Group and one in the upper Missourian Lansing Group. Zone 1 encompasses the Hertha, Swope, and Winterset Limestones. *Neokoninckophyllum tushanense* ranges throughout the three formations and commonly dominates coral faunas. Identification of this zone outside of Kansas is uncertain; however, neokoninckophyllids resembling *N. tushanense* and other elements of the zone are found in Oklahoma and Iowa. The presence of *N. kansasense* in the Westerville Limestone in Kansas and Missouri characterizes Zone 2. Zone 3 is characterized by *Dibunophyllum* n. sp., *Caninia torquia,* and *Geyerophyllum* n. sp. of the Cement City Limestone. Farther north in Missouri only *C. torquia* is present. Zone 4 includes the Wyandotte, Plattsburg and Stanton Formations. The most diagnostic coral is *Dibunophyllum parvum* which ranges through the Stoner Limestone, Stanton Formation and may be replaced in the South Bend Limestone of the Stanton by a similar form here referred to a new species. *D. valeriae* ranges throughout the zone and is commonly found with *D. parvum.* A new species of *Neokoninckophyllum* and *Geyerophyllum* sp. cf. *G. broilii* are present throughout the Wyandotte and Plattsburg Formations. Zone 4 has been tentatively identified in the Missourian units of Texas and Iowa on the presence of forms similar to *Dibunophyllum parvum.*

Dibunophyllum parvum, which appears first in the lower Wyandotte Formation, shows the only documented evolutionary sequence in the corals studied here. Corals belonging to the lineage are small and possess septa which rise above the epitheca in the calicular region. Changes within the lineage include 1) acquisition of a more pronounced lanceolate septum, 2) increased zigzag pattern in the septa, 3) decrease in steepness of outer dissepiments, and 4) increased variability of the axial structure. Culmination of these trends probably led to development of a described new species in uppermost Missourian rocks, to *D. perplexum* in lower Virgilian of Kansas and to other species in Virgilian and Permian units of Texas.

INTRODUCTION

Missourian rocks of eastern Kansas provide excellent opportunity for the study of dissepiment-bearing rugose corals. A sound stratigraphic framework has been provided by earlier stratigraphers and in most instances, stratigraphic units can be identified easily along the outcrop belt. Typically, Missourian limestone formations consist of interbedded limestones and thin calcareous shale lentils which afford excellent collecting. Most fossiliferous Missourian units are exposed in large numbers of roadcuts and quarries in the Kansas City area. Particularly near the southern extent of most limestone formations, quarrying operations have exposed greatly thickened algal mound complexes which locally contain abundant rugose corals. Unfortunately, most corals are surrounded by limestone matrix from which they are difficult to extract.

This paper represents the first attempt toward a comprehensive study of Upper Pennsylvanian dissepimental corals from the Midcontinent. However, several taxonomic papers concerned with limited numbers of speci-

mens and taxa have been published. For further discussion of these papers, see JEFFORDS (1948a), COCKE (1966), and COCKE & COCKE (1968). In a review report, JEFFORDS (1948b) noted two dissepimental genera, *Dibunophyllum* and *Pseudozaphrentoides,* in several Missourian limestone and shale formations.

ACKNOWLEDGMENTS

I extend special thanks to Dr. W. M. FURNISH, Professor of Geology, University of Iowa, for guidance and criticism during various stages of the investigation. Drs. B. F. GLENISTER and GILBERT KLAPPER of the University of Iowa are gratefully acknowledged for criticism and suggestions to improve the presentation. I wish to thank the Geology Department and Graduate College of the University of Iowa for financial aid during the final year of research in which I worked as research assistant under Dr. FURNISH. HARRELL STRIMPLE, Curator of the Repository, Geology Department, University of Iowa, is acknowledged for first introducing me to rugose coral collecting and for many helpful discussions on stratigraphic and paleontological problems. I thank RICHARD BEINERT and W. B. SAUNDERS, University of Iowa, for discussions of similar problems and for aid in photographic problems.

Staff members of the Geologic Research Section, Kansas Geological Survey were most helpful. Dr. D. F. MERRIAM, Chief, made funds and equipment available to me during much of the study. Drs. JOHN C. DAVIS and CURT CONLEY, Research Associates, gave technical aid in photography and many helpful suggestions. Special thanks are extended to Dr. P. H. HECKEL, Research Associate, for innumerable favors including stratigraphic, paleoecological, and sedimentological discussions, collection of Stanton dissepimental corals, and locality information.

I am much indebted to an old friend, the late Dr. J. M. JEWETT, Senior Geologist Emeritus of the Kansas Geological Survey, who spent many hours in the field and in discussion with me on the problems of Missourian paleontology and stratigraphy.

I wish to thank NAN COCKE for assistance in collecting material, editorial advice, and for typing the manuscript. Many people aided in collecting; to these I extend my gratitude.

Thanks are extended to the Smithsonian Institution for loan of the Girty coral collection and to the Field Museum for loan of *Campophyllum kansasense* type specimens.

Finally, a grant from the American Association for the Advancement of Science granted through the Iowa Academy of Science allowed me to compare Missourian corals of Iowa to those of Kansas.

STRATIGRAPHY AND CORAL DISTRIBUTION

GENERAL STATEMENT

An excellent summary of the history of Missourian stratigraphy has been given by MOORE (1935). Missourian rocks crop out in a northeasterly band 25 to 40 miles wide (Fig. 1) and are underlain and overlain respectively by Desmoinesian and Virgilian units. Thickness ranges from 400 feet near Kansas City to approximately 700 feet near the Kansas-Oklahoma boundary. Missourian rocks are characterized by the fusulinid genus *Triticites* which extends through the overlying Virgilian and Permian rocks. Previous workers have been impressed by the alternation of thin, laterally persistent limestone and thick shales, siltstones and sandstones which were thought to be at least in part nonmarine (Fig. 2). MOORE (1935) proposed a cyclothem classification for units involved in these alternations. According to this concept, each of the limestone units represents similar marine conditions and repeated occurrence of these marine beds indicates a specific stage in the advance and retreat of shallow Pennsylvanian seas.

STRATIGRAPHY AND FACIES DISTRIBUTION

Recently, HECKEL & COCKE (1969) have shifted emphasis from recognition of repetitive sequences to lateral facies distribution patterns. They divided outcropping Missourian rocks into three facies belts. In a north to south pattern, these are 1) normal limestone belt, 2) phylloid algal mound complex belt, and 3) clastic belt. Belts 1 and 2 are defined by the distribution of different lithic types within a given limestone unit. The third belt is defined by the preponderance of clastics which may contain lenticular limestones.

NORMAL LIMESTONE BELT

Typically, the limestones are thin, commonly less than 15 feet thick. Brachiopods, bryozoans, crinoids, and corals are common in most units. Locally, however, some limestones are barren. Algae are particularly rare. Although lithology is highly variable both within a given limestone and between stratigraphically separated limestones, little work has been done on facies differentiation within this belt. Preliminary work suggests that most units have an increase in organic content in the upper part of a formation.

Three kinds of shale are commonly present within limestone formations: 1) fissile marine black shale, where present found near the base of limestone units, 2) thin calcareous shales forming numerous lenticular interbeds with limestones, and 3) green shale, generally associated with marly cobbles near the top of a few limestones. Only the calcareous shales contain abundant invertebrates.

Lateral relationships between the normal limestone belt and the algal-mound complex are not well known. In some instances, the normal limestone seemingly increases in thickness and algal content to become an algal complex; in other cases, the normal limestone sequence continues below the thick complex for some distance with no apparent lateral intergradation.

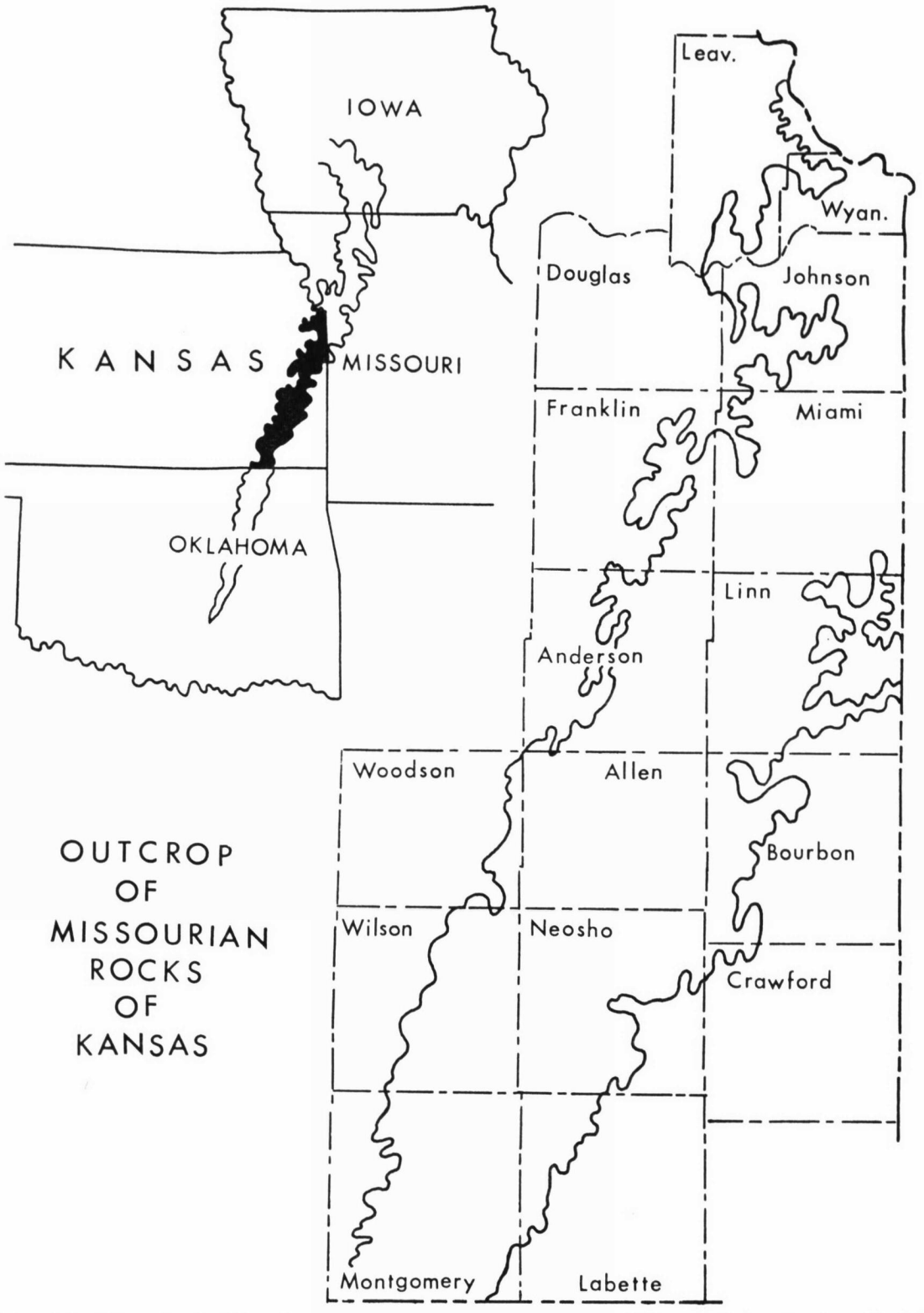


FIG. 1. Outcrop belt of Pennsylvanian Missourian rocks in Iowa, Missouri, Kansas, and Oklahoma. Darkened outcrop band in the smaller map is the same as that shown on the larger map on the right and represents the area studied in this report.

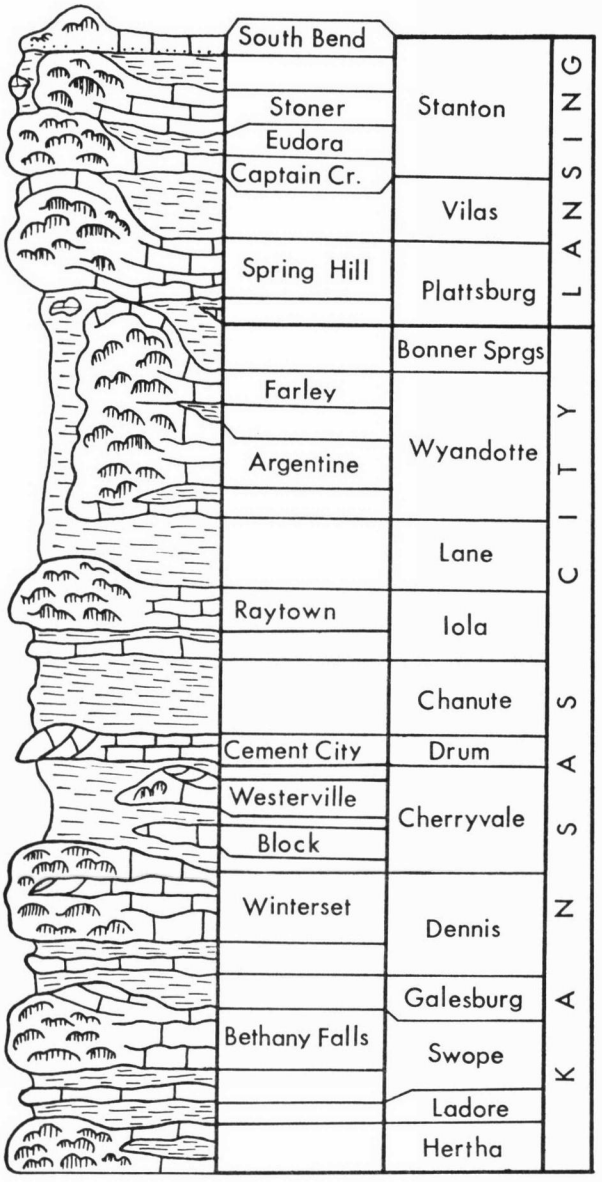


FIG. 2. Stratigraphic column of Pennsylvanian Missourian rocks in Kansas. Note that the Pleasanton Group and names of limestone members which bear no dissepimental corals are omitted. Hachures indicate phylloid algal mound complex. Thickness ranges from 400 to 700 feet. (Modified from Heckel & Cocke, 1969, p. 1059).

Clastic formations which lie between limestone units outside of the algal-mound-complex belt are thick and generally consist of nonmarine to marine shales and siltstones, and rarely of sandstone. Laterally, they are unfossiliferous to poorly fossiliferous; zones of invertebrate-rich nodules and fossiliferous calcareous shales are relatively common in a few units. Cross-bedded siltstones containing plant fragments may grade laterally into invertebrate-rich calcareous shales and limestones. These "in between" clastics of the normal limestone belt differ from those of the clastic belt in containing lesser amounts of both sandstone and mollusk-bearing calcareous shales.

ALGAL-MOUND-COMPLEX BELT

Near the southern limit of all Missourian limestone formations except one, phylloid algal-mound complexes are present in the outcrop. Only the Drum Formation forms no algal-mound complex (for further discussion of this unit see section on Distribution of Dissepimental Corals below). In addition, the Westerville Limestone Member of the Cherryvale Shale Formation forms an algal-mound complex near its southern extent. Characteristic features of algal-mound complexes include 1) a two-to-tenfold thickening of the limestone unit and 2) an increase in phylloid algal components to form the **mound** or main body of the algal-mound complex, and 3) wide diversity of limestone types both at the top and surrounding the complex, which are referred to as the **associated facies** of the phylloid algal-mound complex.

The mound comprises the central part of the algal-mound complex and may extend from less than 1 mile to more than 60 miles along outcrop. It is characterized by a wide range of calcilutites and calcarenites that are rich in phylloid algae. Mounds tend to be massively bedded. Of particular interest to paleontologists are small hummocks and accompanying troughs which, in contrast to adjacent limestone, contain abundant invertebrate fossil material, particularly crinoids, corals, and bryozoans. Generally, these features are small; heights and widths seldom exceed a few feet. It is probable that the troughs acted as passageways for currents carrying fresh sea water and nutrients. Except for algal and bryozoan remains, mound rock contains relatively few fossils; however, those represented differ little from the invertebrates of the normal facies belt. Similarly, thin local calcareous shales within the mound have varied faunas.

A varied suite of calcarenites, calcilutites, and calcareous shales overlies and rims algal mounds and constitute the associated facies. Except for abundance of oolitic limestones, these rocks resemble those of the normal limestone belt both lithically and faunally. Crinoidal calcarenites containing limited amounts of other organic debris are common both as bar and channel deposits on the top of algal mounds. Associated thin beds of crinoidal calcarenites from one complex dip steeply into shales and siltstones of the clastic belt. Oolitic calcarenites may attain several feet in thickness over the tops of mounds. They are poorly to richly fossiliferous and may be cross-bedded. One complex (southern Plattsburg) is bordered on the north by oolitic to pisolitic calcarenite. It grades westward to a myalinid-rich, crinoidal calcarenite. Channel deposits consisting of several feet of calcarenites rich in bryozoan, crinoidal, brachiopodal and coralline debris are present near the margins of several mound com-

plexes. Generally, associated calcilutites are similar lithically and faunally to normal belt calcilutites. Laminated calcilutites containing little or no invertebrate remains are present on the top of some mounds as are invertebrate-rich calcareous shales interbedded with calcarenites and calcilutites described above.

CLASTIC BELT

South of each algal-mound complex is a thick clastic sequence of shales and siltstones and lesser numbers of limestones and sandstones. Mollusk-bearing calcareous shales are locally prominent. Particularly common in Kansas are sponge and *Ottonosia*-bearing calcilutites and crossbedded fossiliferous oolites. Because none contain dissepimental corals, they will not be discussed here; however, local algal-mound complexes within the clastic belt in northeastern Oklahoma contain some of the most prolific dissepimental coral faunas known in the Pennsylvanian Midcontinent.

DISTRIBUTION OF DISSEPIMENTAL CORALS

The following discussion attempts to elucidate the relationship between particular facies patterns and the distribution of dissepimental corals. Difficulties arise in relating coral distribution to facies patterns. The apparent scarcity of corals in algal calcilutites of the phylloid algal-mound complexes may be due in part to the relatively greater density of this rock and the general scarcity of easily eroded shale beds. Abundance of corals varies considerably along the outcrop belt; additional quarries and roadcuts may reveal large numbers of corals from seemingly barren limestones. Missourian limestones in the Oklahoma clastic belt are only mentioned, because no corals from them are described here.

HERTHA FORMATION

In the normal facies belt the Hertha Formation consists of three members, in ascending order, Critzer Limestone, Mound City Shale, and Sniabar Limestone. In the algal-mound complex of Linn and Bourbon Counties, members cannot be differentiated.

Flaring forms of *Geyerophyllum jewetti* Cocke, n. sp., occur near the Kansas-Missouri boundary in the vicinity of Missouri City, Missouri, accompanied by *Dibunophyllum bourbonense* Cocke, n. sp., in the calcilutites and calcarenites of the Critzer Member.

Southward, throughout most of Linn County, Kansas, the small dibunophyllid *Dibunophyllum bourbonense* occurs in the Sniabar Member which consists of fossiliferous nonalgal calcilutite. Near the northern edge of the algal mound complex, *Caninia linnensis* Cocke, n. sp., *Neokoninckophyllum perplexum* Cocke, n. sp., *N. tushanense,* and *N.* sp. A with large syringoporid colonies are present in algal-rich calcilutite. Farther south in southern Linn County, the undifferentiated Hertha, consisting of sparry algal calcilutite and algal calcarenite contains the largest known individuals of the coral *Geyerophyllum jewetti* Cocke, n. sp., in growth position. The species, with syringoporoid colonies, commonly forms small positive areas surrounded by sparry algal calcilutite. *G. jewetti* in growth position is particularly abundant in algal calcilutite near the northern margin of the algal-mound complex. *Dibunophyllum bourbonense* Cocke, n. sp., occurs at Loc. H8 in the calcareous shale, a few inches below the Hertha mound complex. No corals were found in the thin calcarenite and calcilutite beds south of the algal-mound complex.

SWOPE FORMATION

Three members of the Swope Formation—Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone—are identifiable in the northern part of the outcrop belt.

The rugose corals, *Neokoninckophyllum tushanense* (Chi, 1931) and *N. acolumnatum* Cocke, n. sp., are present only in the lower nodular alternating calcareous shales and calcilutites in Linn County. Within the several subfacies of the Bethany Falls delineated in the normal belt by John Mossler (University of Iowa) no dissepimental rugose corals have been found by me. In southern Linn County, *N. tushanense* is present in calcareous shales near the top of the Bethany Falls. Within the prominent algal-mound complex of Neosho County, a single specimen of *Geyerophyllum patulum* Cocke, n. sp., surrounded by sparry algal calcilutite has been collected.

DENNIS FORMATION

The Dennis Formation, consisting of Canville Limestone, Stark Shale, and Winterset Limestone, has no dissepimental corals in its northern outcrop area. Near the Miami-Linn County line, *Neokoninckophyllum tushanense* (Chi, 1931) and *N. acolumnatum* Cocke, n. sp., are abundant in thin calcareous shales lying between nonalgal calcilutite beds of the upper Winterset Member. None are in growth position. Accompanying the corals are well-preserved *Neospirifer* sp., *Antiquatonia* sp., and *Linoproductus* sp., with abundant crinoids and bryozoans. Farther south, no dissepimental corals have been collected in the normal limestones. In an abnormal section of Winterset along *Alignment-1* of Heckel & Cocke (1969, fig. 2) *N. tushanense* and *N. acolumnatum* reappear abundantly in growth position along calcareous shale interbeds between algal calcilutites. One specimen of *Geyerophyllum patulum* Cocke, n. sp., has been collected from the sparry algal calcilutite of the Winterset algal-mound complex. Specimens of *Dibunophyllum hystricosum* Cocke, n. sp., have been collected from the sparry algal calcilutites and calcarenites near the Winterset algal-mound complex in Neosho County.

The Hogshooter Formation of Oklahoma, which according to OAKES (1940) is equivalent to the Dennis Formation, has two phylloid algal-mound complexes. The northern Winterset mound complex of Washington County, Oklahoma, has no dissepimental corals. In contrast, the mound complex of the Lost City Member of Tulsa County, Oklahoma, has unidentified species of *Dibunophyllum, Neokoninckophyllum,* and *Caninia* enclosed in sparry algal calcilutite.

CHERRYVALE FORMATION

The Cherryvale is primarily a shale sequence in northeastern Kansas containing two limestones, the Block and Westerville Members. Near its type locality in Miami County, Kansas, the Block Limestone consists of up to 8 feet of normal interbedded calcareous shale and nonalgal calcilutites containing abundant invertebrates. The lower beds contain the dissepimental corals *Geyerophyllum patulum* COCKE, n. sp., and *Neokoninckophyllum petilum* COCKE, n. sp., at a single locality. Most are imbedded seemingly in growth position in nonalgal calcilutite.

The Westerville Limestone has not been investigated in its normal limestone belt in Missouri; in the Kansas City metropolitan area it has a wide range of facies. It is an algal-mound complex in Kansas City, Kansas, consisting of several feet of sparry algal calcilutite interspersed with lenticular highly fossiliferous shale and is overlain by several inches of fossiliferous oolite. Both the calcareous shales and sparry algal calcilutites contain *Neokoninckophyllum kansasense* (MILLER & GURLEY, 1893). Variant-1 of the species is considerably more common than variant-2. Many of the specimens are in growth position. A few miles northward, the phylloid algal-rich rock is replaced by laminated calcilutite probably of supratidal origin; no corals and few other invertebrates are present. A short distance eastward in Kansas City, Missouri, the Westerville is represented by several feet of invertebrate-bearing oolitic calcarenite. Hundreds of *N. kansasense* variant-2 occur in the calcareous shale at the surface of the oolitic body. Few representatives of variant-1 are present.

DRUM FORMATION

It is traditional to consider that the Drum Limestone consists of the Cement City Limestone below and the Corbin City Limestone above. It is doubtful that the Drum Limestone of the type area in southern Kansas can be traced into the "Drum Limestone" near Kansas City. It is more likely that the type Drum is an isolated oolitic bar deposit in the clastic facies belt which lies near the stratigraphic level of the northern "Drum." Further, correlation of the Dewey Limestone of Oklahoma with the typical Drum (MOORE, 1948) is erroneous; hence, the usage of the "Dewey" adopted by ZELLER *et al.* (1968) for the lower Drum of northeastern Kansas is unacceptable.

I suggest that the term "Drum" be applied only to the oolitic limestone in southern Kansas and that the entire "Drum" of the Kansas City area be referred to as "Cement City." The term "Corbin City" serves no useful purpose, particularly in the Kansas City area and should be dropped.

The Drum near the type section contains abundant lophophyllids and micheliniid corals but dissepimental corals have not been collected.

The Cement City Member of metropolitan Kansas City includes 2 to 10 feet of poorly fossiliferous calcilutite capped locally by highly fossiliferous oolite or bioclastic calcarenite to which the name Corbin City has been applied. No algal-mound complex occurs in the formation. Within the calcilutite, thin calcareous shales carry an abundant fauna of rugose corals, bryozoans, productid brachiopods, teguliferinid brachiopods, and molluscans. Dissepimental corals include *Dibunophyllum clathrum* COCKE, n. sp., *Geyerophyllum girtyi* COCKE, n. sp., and *Caninia torquia* (OWEN). Few are in living position.

The Dewey Formation of northeastern Oklahoma, which OAKES (1940), and MOORE (1948) and ZELLER *et al.* (1968) erroneously consider equivalent to the Drum Formation is an impressive phylloid algal-mound complex. The lower 5 to 8 feet consist of thin interbeds of calcareous shales and algal calcilutites which contain abundant corals including *Caninia* sp., *Dibunophyllum brucei* COCKE (1966), and *Geyerophyllum* sp. Large numbers of the corals which are imbedded in the algal calcilutite appear to be in living position. The massive sparry algal calcilutite above contains only rare specimens of *Caninia.* Associated skeletal calcarenites and shaly cobbly calcilutites overlie the algal mound and contain dissepimental corals including *Caninia* sp., *D. oklahomense* COCKE (1966), and *Geyerophyllum* sp.; most specimens are abraded.

IOLA FORMATION

In the normal facies, the Iola Formation consists in upward order of the Paola Limestone Member, Muncie Creek Shale Member and Raytown Limestone. In the Kansas City area the Paola is an algal calcilutite but differs from typical mound rock in containing encrusting blue-green algae and the Muncie Creek is a black shale. The Raytown has a relatively prolific fauna of lophophyllids, brachiopods, and bryozoans. Dissepimental corals represented only by *Dibunophyllum elegente* COCKE, n. sp., are found in nonalgal calcilutite at a single locality in northern Linn County, Kansas. The exposure is poor and little is known of the accompanying fauna. The Raytown algal mound extends in Kansas from southern Anderson County to northern Neosho County. It is slightly less than 40 feet thick and is composed

largely of sparry algal calcilutite. Extensive collecting has revealed no dissepimental corals in the algal-mound complex rocks.

In northeastern Oklahoma, the Avant algal-mound complex which is approximately stratigraphically equivalent to the Kansas Iola Formation forms a 40-foot thick complex. South of the complex in northern Tulsa County, Oklahoma, a single poorly preserved geyerophyllid has been collected from an invertebrate-rich calcilutite. STRIMPLE & COCKE (1969) have questioned the placement of the Avant Limestone in the Iola Formation.

WYANDOTTE FORMATION

In addition to two shale members, Quindaro and Island Creek, the formation consists of three limestone members in ascending order, the Frisbie, Argentine, and Farley. No dissepimental corals have been collected in the Frisbie Member.

CROWLEY (1966) has delineated two algal-mound complexes in the Argentine and two in the Farley Member. Dissepimental rugose corals occur throughout both mound complexes of the Argentine Limestone. *Dibunophyllum parvum* COCKE (1969) is particularly abundant, with numerous invertebrates and phylloid algae on bedding plane irregularities in the lower portion of the limestone. The species occurs sporadically in invertebrate-rich calcarenites and calcilutites of the normal facies. For a fuller discussion of the paleoecological implications of this fauna, see COCKE (1969). In both northern and southern algal-mound facies solitary *Neokoninckophyllum variabile* COCKE, n. sp., and *Dibunophyllum valeriae* are rare. *Geyerophyllum* sp. cf. *G. broilii* with spinose columella are unevenly distributed throughout both complexes. All are particularly abundant along calcarenitic lenses and thin calcareous shale beds. These geyerophyllids are more broadly flaring than most stratigraphically higher forms.

Similarly, specimens of *Geyerophyllum* sp. cf. *G. broilii* are randomly distributed throughout both Farley algal-mound complexes except at Loc. Wy3 where they occur in great profusion on the upper surface of the highest algal-rich calcilutite. Here they are conicocylindrical and fasciculate and have stellate columellae. A few abraded forms are found a few inches higher in the skeletal calcarenite which caps the complex. *Neokoninckophyllum variabile* is particularly abundant along shale breaks between algal-rich beds with numerous invertebrates including bryozoans, brachiopods, and lophophyllids. The species dominates the coral faunas in upper beds at Loc. Wy1 where the overlying Bonner Springs is extremely thin or lacking over the northern Farley complex.

PLATTSBURG FORMATION

In the northern outcrop area members of the Plattsburg Formation in ascending order are Hickory Creek Shale, Merriam Limestone, and Spring Hill Limestone. Although the subdivisions cannot be clearly differentiated in all parts of this region, they are accepted provisionally here. South of Allen County, Kansas, the tripartite division is considered to be unrecognizable and the rocks are referred to collectively as Plattsburg Formation because 1) stratigraphic evidence suggests that the southern extension of the formation may originate from the upper part of the Spring Hill Limestone, 2) the "Hickory Creek Shale" of the southern area is lowest of many similar shales in an interbedded limestone and shale unit that varies from 10 to 45 feet, and 3) the southern "Spring Hill" is a massive but localized algal-mound complex only indirectly related to the northern Spring Hill, which forms a second algal-mound complex in Anderson and Allen Counties.

Dissepimental corals have not been collected from the Merriam and Hickory Creek Members. Within the Spring Hill in its normal belt the conicocylindrical corals *Neokoninckophyllum variabile* COCKE, n. sp., *Dibunophyllum parvum, D. valeriae* and *Geyerophyllum* sp. cf. *G. broilii* occur locally in abundance in local calcarenitic seams in the middle and upper parts of the member. Few are in growth position and many are abraded. Occurring with these corals are abundant brachiopods (*Composita* sp., *Hustedia* sp., *Punctospirifer* sp., *Enteletes* sp.) as well as the coral *Stereostylus* sp., fenestrate bryozoans, and numerous crinoid remains.

The normal limestone becomes increasingly algal southward and thickens to form an algal-mound complex which has maximum development in Anderson County, Kansas. Interspersed in the upper part of the complex are localized lenses of skeletal calcarenite, algal calcilutite, and sparry algal calcilutite. Dissepimental corals are rare in the algal calcilutite, absent in the sparry algal calcilutite, but particularly abundant in skeletal calcarenites with the massive stromatoporoid *Parallelopora* sp. Corals include *Neokoninckophyllum variabile, Dibunophyllum valeriae, D. parvum,* and *Geyerophyllum* sp. cf. *G. broilii.*

Geyerophyllum garnettense COCKE, n. sp., occurs only at Loc. Pb5 along the eastern boundary of the Plattsburg outcrop. Here, the rock contains sparse algae and abundant invertebrates. *Neokoninckophyllum variabile, Dibunophyllum parvum,* and *D. valeriae* accompany this species.

Farther south, in northern Allen County, rocks of the northern algal-mound complex contain no dissepimental corals. However, algae and sponges increase in number. South of the northern algal-mound complex, no dissepimental corals are present in the undifferentiated Plattsburg which consists largely of sponge-rich limestone and shale interbeds which contain abundant fenestrate bryozoans, molluscans, marginiferid brachiopods, and

crinoids. The upper beds contain lesser numbers of sponges and more numerous brachiopods (*Neospirifer* sp., *Composita* sp.).

A prominent algal-mound complex is seen in the Plattsburg of Wilson and Montgomery Counties, Kansas. It overlies as much as 45 feet of sponge-rich interbeds of calcilutite and shale which contain no dissepimental corals but have relatively abundant individuals of *Lophophyllidium* sp. Within the 100-foot thick complex, dissepimental corals are extremely rare. *Neokoninckophyllum variabile, N. acolumnatum* Cocke, n. sp., and *Dibunophyllum valeriae* occur in relative abundance on hummocks and in troughs of the middle part of the algal rocks. In striking contrast to the surrounding phylloid algal-rich calcilutite, the surfaces of these structures contain prolific faunas of both fenestrate and ramose bryozoans, large basket calcisponges, brachiopods, snails, and crinoids. The troughs represent probable local sources of nutrient-rich waters which supported the invertebrate fauna (Heckel & Cocke, 1969).

Dissepimental corals are found in two other areas. One, at the western edge of the complex outcrop, contains abundant *Neokoninckophyllum variabile* and *N. acolumnatum* in the transitional limestone and calcareous shale between the upper Plattsburg and lower Stanton where the intervening Vilas Shale cannot be identified definitely. These beds are placed arbitrarily here in the upper Plattsburg. Two, a single specimen of *Neokoninckophyllum variabile* has been collected from Loc. Pb13 in a barlike pisolite deposit a short distance north of the southern Plattsburg algal buildup. It is badly abraded, encrusted by bryozoans, and accompanied by abundant *Dielasma* sp., myalinids, and crinoids.

Despite exhaustive collecting, only a single specimen doubtfully included in *Geyerophyllum* has been collected from the southern Plattsburg algal-mound complex. Scarcity of dissepimental corals, particularly geyerophyllids, is strikingly different from their abundance in the northern complex where geyerophyllids dominate the prolific coral fauna.

STANTON FORMATION

In the normal facies belt, the Stanton Formation consists of the following members in upward order: Captain Creek Limestone, Eudora Shale, Stoner Limestone, Rock Lake Shale, and South Bend Limestone. Within the normal facies belt these units are easily delineated but their identification may be somewhat arbitrary south of Anderson County, Kansas. Presence of abundant *Caninia torquia* (see below) in lowermost limestone at the northern edge of the southern belt of Stanton algal complexes, as well as in normal northern Stoner beds, suggests that the Captain Creek Member does not occur in central Wilson or in Montgomery Counties, Kansas. Because independent stratigraphic evidence is not available to me, the term Captain Creek is utilized for the lowermost limestone in both the normal and algal-mound complex facies.

The Captain Creek, locally comprised of algal calcilutite within its normal belt, contains rare *Dibunophyllum parvum*. The algal-mound complex in Wilson County has yielded few rugose corals. Farther south in Montgomery County, sparry algal calcilutite thickens to 45 feet and locally contains abundant *Neokoninckophyllum heckeli* Cocke, n. sp. Generally this species is sporadically distributed throughout the sparry algal calcilutite or concentrated along bedding surfaces. At Loc. St8, however, this species is present in growth position on large basket-shaped calcisponges. See discussion of Plattsburg Formation for corals occurring in transitional beds between the Plattsburg and Stanton.

Corals are missing to locally abundant in the Stoner Limestone. Locally, in the normal belt, with careful collecting, *Dibunophyllum parvum* can be obtained in fairly large numbers. *Caninia torquia* has been collected as far north as northern Franklin County but there it is exceedingly rare. Similarly, *Geyerophyllum cylindricum* is very rare. Two unidentifiable coral fragments which may represent this species have been collected in Franklin County. Caniniids increase sharply in number southward.

In central Anderson County, the Stoner thickens to form an algal-mound complex from which only *Caninia torquia* has been collected. South of this complex, hundreds of specimens belonging to the species are present in the invertebrate-rich limestones and calcareous shales.

A thick linear channel deposit of skeletal calcarenite is present in central Wilson County at the Captain Creek-Stoner level (Heckel, 1966, Heckel & Cocke, 1969). In addition to dissepimental corals, it contains abundant algae, and fenestrate bryozoan, brachiopod, and crinoid fragments. Particularly characteristic of the deposit are the bryozoan *Glyptopora* sp. and the brachiopod *Schizophora texanum*. *Caninia torquia* is more abundant at the western end of the channel exposure although specimens can be collected in small numbers at most localities in the channel rock. *Neokoninckophyllum heckeli* Cocke, n. sp., *Dibunophyllum valeriae* Newell (1935) and *Geyerophyllum cylindricum* (Dobrolyubova & Kabakovich, 1948) are abundant throughout the channel but are most common in the middle portion. All corals collected are considerably abraded, and may bear an epifauna. This channel deposit contains the only abundant geyerophyllids found in algal-mound complexes.

In contrast to absence of corals in normal facies, the South Bend algal-mound complex of northwestern Montgomery County, Kansas, contains abundant *Dibunophyllum dibolium* Cocke, n. sp., in algal calcilutite accompanied by *Neokoninckophyllum heckeli* and *Dibunophyllum valeriae*. A short distance south of the algal

mound terminus, *D. dibolium* occurs abundantly at the top of the invertebrate-rich nonalgal calcilutites of the South Bend.

The Wann Formation of northeastern Oklahoma is partially equivalent to the Plattsburg-Stanton of Kansas. It contains a small algal-mound complex in northern Washington County, Oklahoma, which contains no rugose corals. However, a 40-foot algal-rich limestone in southern Washington County contains abundant neokoninckophyllids, and small dibunophyllids, resembling *Dibunophyllum parvum*.

EVOLUTIONARY TRENDS

Few well-defined evolutionary trends can be delineated in the corals studied here. Cylindrical neokoninckophyllids, dibunophyllids, and geyerophyllids become progressively more abundant in the higher beds studied. Early cylindrical neokoninckophyllids are *Neokoninckophyllum cystosum* Cocke, n. sp., of the Hertha Formation, *N. acolumnatum* Cocke, n. sp., of the Hertha, Swope, and Stanton Formations, and *N. kansasense* var. 1 from the Westerville Limestone, Cherryvale Formation. Of the geyerophyllids, only *Geyerophyllum jewetti* Cocke, n. sp., from the Hertha and *G.* sp. A from the Swope Formation are cylindrical. Early dibunophyllids which are cylindrical comprise some members of *D. bourbonense* Cocke, n. sp., from the Hertha Formation and *D. elegente* Cocke, n. sp., from the Iola Formation. Except for the general trend mentioned, none other is recognized in the caniniids, neokoninckophyllids and geyerophyllids.

Small dibunophyllids, characterized by conical shape, small size, and septa which rise above the epitheca, form the *Dibunophyllum parvum* lineage, possessing the only well-documented trend in Missourian dissepiment-bearing corals. Morphological changes involved in Missourian members of this lineage are 1) acquisition of a more pronounced lanceolate character of both major and minor septa, 2) increased zigzag pattern in the outer one-half of the septa to become subcarinate or carinate, 3) decrease in steepness of outermost dissepiments, and 4) increased variability of the axial structure.

An early representative of the lineage is probably *Dibunophyllum* sp. cf. *D. bourbonense* from the lower Missourian Hertha Formation. The major and minor septa are sublanceolate to lanceolate; they are thin and smoothly crooked near the corallite periphery. Dissepiments are steep and the columella consists of a stout spinose median lamella combined with relatively few radiating lamellae. No representatives of the lineage have been collected in the overlying Swope, Dennis, Drum, or Iola Limestone Formations.

Dibunophyllum parvum where first observed in the uppermost Kansas City Wyandotte Formation shows that most specimens have distinctly lanceolate major and minor septa. A zigzag pattern which simulate carinae may be present in the outer one-half of both orders of septa. The dissepiments are gently inclined. Representatives of the species in the higher units of the Plattsburg and Stanton Formations show that most corallites possess lanceolate septa which are considerably thicker than in earlier forms and their outer limits are carinate. Dissepiments are slightly less inclined. A comparable stage of evolution is represented by *Dibunophyllum* sp. A described by Stewart (1961) from the Wolf Mountain, upper Missourian, of Texas and by an undescribed form from upper Missourian beds of Iowa.

Dibunophyllum dibolium Cocke, n. sp., of the uppermost Missourian South Bend Limestone, is an advanced form of *D. parvum* in which the outer rows of dissepiments are oppositely inclined and the columella is more complex. All major and minor septa are lanceolate and carinate.

Knowledge of the lineage in rocks younger than Missourian is limited but available evidence strongly suggests that the lineage continues at least to uppermost beds of the Virgilian limestones.

A more advanced form is *Dibunophyllum perplexum* Cocke (1969) from the lower Virgilian of Kansas. Some individuals can be differentiated from lanceolate septa-bearing members of *D. parvum* with difficulty. However, all specimens have lanceolate septa which are zigzag to carinate in the outer limits. The columella shows great plasticity; some forms have a dibunophylloid columella; others have no axial structure but only widely spaced irregular tabulae. Other specimens exhibit combinations of these. Morphological variability in the axial region marks other probable members of the lineage.

Two unidentified species of Virgilian dibunophyllids from Texas are probable representatives. One, a form from the Blach Ranch Limestone, Cisco (Virgilian), has carinae-bearing lanceolate septa, dibunophylloid columellae (at least in some specimens) and an outer zone of blisterlike dissepiments (Stewart, 1961). Another dibunophyllid collected by me from a thin limestone near the Pennsylvanian-Permian boundary is similar but shows a more diverse axial structure, which 1) may be typically dibunophylloid, 2) consist entirely of small tabular cysts, or 3) have a vorticular arrangement of septal lamellae and closely packed tabellae.

On the basis of internal morphology, a fasciculate form, *Heritschioides* sp. Ross & Ross (1963) (=*Yabeiphyllum rossi* Minato & Kato, 1965a) from the *Uddenites*-bearing Virgilian beds on the Neal Ranch, Wolfcamp Hills, West Texas, is considered part of the lineage. However, corallites within a single corallum of this species possess carinae-bearing lanceolate septa or thin slightly crooked septa. The columella as illustrated is typically dibunophylloid or a meshwork of lamellae and intersected tabellae.

TABLE 1. *Distribution and Zonation of Dissepimental Coral Species, Pennsylvanian Missourian Limestones of Kansas.*

	Hertha	Swope	Dennis	Block	Westerville	Cement City	Iola	Wyandotte	Plattsburg	Stanton
Dibunophyllum										
bourbonense COCKE, n. sp.	X									
sp. cf. *D. bourbonense* COCKE, n. sp.	X									
hystricosum COCKE, n. sp.		X	X							
clathrum COCKE, n. sp.						X				
elegente COCKE, n. sp.							X			
parvum COCKE, 1969								X	X	X
dibolium COCKE, n. sp.										X
valeriae NEWELL								X	X	X
Neokoninckophyllum										
cystosum COCKE, n. sp.	X									
perplexum COCKE, n. sp.	X									
tushanense (CHI)	X	X	X							
acolumnatum COCKE, n. sp.	X	X	X						X	X?
petilum COCKE, n. sp.				X						
kansasense (MILLER & GURLEY)					X					
variabile COCKE, n. sp								X	X	
heckeli COCKE, n. sp.										X
sp. A	X									
Caninia										
linnensis COCKE, n. sp.	X									
torquia (OWEN)						X				X
Geyerophyllum										
jewetti COCKE, n. sp.	X									
sp. A		X								
patulum COCKE, n. sp.		X	X	X						
girtyi COCKE, n. sp.						X				
sp. cf. *G. broilii* HERITSCH								X	X	
garnettense COCKE, n. sp.									X	
cylindricum (DOBROLYUBOVA & KABAKOVICH)										X
		Zone 1			Zone 2	Zone 3			Zone 4	

RUGOSE CORAL ZONATION

Most dissepimental corals studied here have rather limited stratigraphic range (Table 1). Approximately one-half of the species are restricted to limestones or thin calcareous shales of a single formation. Many are present in a narrow range of rock types and may reflect particular environmental conditions. Four zones of dissepimental corals are recognized in Kansas. Further research on corals of similar age from other areas is critical for determining both environmental and stratigraphic utility of these zones. Comments on diagnostic fusulinids largely taken from THOMPSON (1957) are also included here because many occur with dissepimental corals and they have proved to be excellent zone fossils. In discussing the occurrence of fusulinids and corals in areas where stratigraphic nomenclature is similar to that of Kansas, care must be exercised because problems of correlation may be masked by such usage.

ZONE 1 is characterized by presence of *Neokoninckophyllum tushanense* (CHI, 1931), which ranges throughout the zone. Coral-bearing units within the now-defined limits of this zone are the Hertha, Swope, and Dennis Limestone Formations. Corals which are not as far ranging stratigraphically as *N. tushanense* include *Dibunophyllum bourbonense* COCKE, n. sp., *D.* sp. cf. *D. bourbonense* COCKE, n. sp., *Neokoninckophyllum cystosum* COCKE, n. sp., *N.* sp. A, *Caninia linnensis* COCKE, n. sp., and *Geyerophyllum jewetti* COCKE, n. sp., from the Hertha Formation. Only a single specimen of *G.* sp. A occurs in the Swope Formation; *D. hystricosum* COCKE, n. sp., is found in both Swope and Dennis Limestones; *N. acolumnatum* COCKE, n. sp., ranges throughout Zone 1 but reappears abundantly in transitional beds between

the Plattsburg and Stanton Formations of the Lansing Group. A particularly useful species is *G. patulum* Cocke, n. sp., which is present in the middle and upper part of the zone, i.e., in the Swope and Dennis Formations but reaches its greatest abundance in the Block Limestone of the Cherryvale Formation which lies above the recognized upper limits of Zone 1.

Characteristic corals of the zone are most abundant in Miami, Linn, Bourbon, and Neosho Counties, Kansas, that is, in the southern part of the outcrop belt. On the basis of preliminary investigation, it is likely that the zone may be identified in other areas of North America. An undescribed species similar to *Neokoninckophyllum tushanense* is found in lower Missourian rocks of Iowa. In addition, *Geyerophyllum rude* (White & St. John), morphologically related to *G. jewetti* of this report and possibly an ecological variant of that species, occurs abundantly in lower Missourian rocks in Iowa. A large neokoninckophyllid from northeastern Oklahoma may be related to *N. tushanense*. This neokoninckophyllid occurs in the Lost City Limestone which, according to Oakes (1940), is equivalent in part to the Dennis Formation of Kansas, although stratigraphic relationship suggests that it is somewhat older. *N. petilum* Cocke, n. sp., of the Block Limestone in the Cherryvale Formation is not included in a zone because it was collected only at a single locality.

In addition to containing characteristic corals of Zone 1, the Bethany Falls Limestone of the Swope Formation and Winterset Limestone of the Dennis Formation, locally contain abundant fusulinids which have been identified from other areas in strata of similar age. The Bethany Falls contains *Wedekindellina ultimata* which is present in Kansas, Missouri, Iowa, Texas, and New Mexico (Thompson, 1957). The *Triticites ohioensis* group of fusulinids is characteristic of the Winterset Limestone in Iowa. According to Thompson (1957) the species has been identified from the Cambridge and Brush Creek Limestones of Ohio and the Livingston and Omega Limestones of Illinois, as well as from a limestone in western Kentucky. Thompson (same paper) has noted that many citations of *T. irregularis* may actually refer to *T. ohioensis*. If this is true, the species also occurs in Kansas, Oklahoma, Texas, and Utah.

Zone 2 corals are found in the Westerville Limestone, Cherryvale Formation and all belong to *Neokoninckophyllum kansasense* (Miller & Gurley). The Westerville Limestone extends a short distance into Kansas where the corals are present in algal calcilutites but more abundantly in calcareous shales. A short distance north and east in Kansas City, Missouri, the species is found only in calcareous shale interbeds at Loc. Wes3 and calcareous shale of Wes2 which overlies a thick oolite bank deposit of the Westerville. Fusulinids have not been described from the Westerville of Kansas; however, *Triticites nebraskensis* and *T. burgessae* are present near the base and top of the unit respectively in Iowa and Missouri.

Zone 3 is identified on the basis of corals which are found in the Cement City Limestone of the Kansas City area. These include *Dibunophyllum clathrum* Cocke, n. sp., *Caninia torquia,* and *Geyerophyllum girtyi* Cocke, n. sp. The zone is not recognizable south of this area but may be identified for several miles into Missouri where it is represented only by *C. torquia*. The generic composition of the Dewey Limestone of northeastern Oklahoma is similar; however, corals of this unit are not included in Zone 3 because 1) the geyerophyllids belong to a different species which in part resembles the *G. jewetti-G. rude* complex, 2) the dibunophyllids *D. brucei* Cocke (1966) and *D. oklahomense* Cocke (1966) are not closely related to *D. clathrum,* and 3) the Dewey caniniids may belong to *C. torquia* but the species is long-ranging and abundance of specimens may be due to environmental factors.

Kansanella tenuis is apparently a long-ranging fusulinid occurring in the Drum Limestone of Iowa, the Iola of Kansas, and the Wyandotte Limestone of Kansas and Iowa. However, correlation of the Drum, Iola and Wyandotte Limestones of Kansas with units in Iowa which bear the same names remains to be verified. Fusulinids are relatively abundant in the Cement City Limestone of Kansas with corals of Zone 3, but to my knowledge have not been described.

Zone 4, which encompasses the Kansas City Wyandotte Formation, Lansing Plattsburg Limestone, Captain Creek and Stoner Limestones of the Lansing Stanton Formation, is characterized by the small distinctive coral *Dibunophyllum parvum* Cocke (1969). The species has not been collected from the uppermost Stanton member, the South Bend Limestone, but may be replaced there by *D. dibolium* Cocke, n. sp., a morphologically similar form. Generally, Zone 4 can be identified by the presence of accompanying corals which occur in most localities of the formations listed above. *Dibunophyllum valeriae* Newell (1935) commonly accompanies *D. parvum* at many localities and has a similar range.

Neokoninckophyllum variabile Cocke, n. sp., is restricted to the Wyandotte and Plattsburg Formations; *N. acolumnatum* Cocke, n. sp., which occurs in the Plattsburg-Stanton transition beds is found also throughout Zone 1 in the lower Kansas City Group. *Neokoninckophyllum heckeli* Cocke, n. sp., is restricted to the Stanton limestones of the southern algal-mound complexes where it is locally abundant. *Caninia torquia* is extremely abundant in the channel calcarenites of the lower Stanton in the southern algal-mound complex (Heckel, 1966). Seemingly this *Caninia*-bearing horizon can be traced into the Stoner Limestone Member of central Kansas. Although the species generally dimin-

ishes in abundance northward, it reaches greatest numbers several miles north of the above mentioned Stanton calcarenites.

Three geyerophyllid species, *Geyerophyllum* sp. cf. *G. broilii* HERITSCH (1936a), *G. garnettense* COCKE, n. sp., and *G. cylindricum* (DOBROLYUBOVA & KABAKOVICH, 1948) are found in Zone 4. The last two are of little stratigraphic utility; *G. garnettense* occurs locally in the northern Plattsburg mound complex and may be an ecologic variant of *Geyerophyllum* sp. cf. *G. broilii*. *G. cylindricum* also occurs only locally in the channel calcarenites of the southern Stanton algal-mound complex.

Geyerophyllum sp. cf. *G. broilii* occurs abundantly in the Wyandotte and Plattsburg units and is very useful stratigraphically in the normal facies of both units, in the algal-complex facies of the Wyandotte, and the northern Plattsburg algal-mound complex. In these facies the species is found in calcareous shale and in a wide range of limestone rock types. However, it has not been identified with certainty from the southern complex of the Plattsburg.

The biostratigraphic potential of Zone 4 is great because specimens similar to those of *Dibunophyllum parvum* have been identified by me from both Iowa and Texas. These corals are present in the Wyandotte Formation of Iowa. STEWART (1961) described a similar form, *D.* sp. A from the Wolf Mountain Shale (Missourian) of Texas. These forms may be progenitors of the Kansas corals and though morphological information is incomplete, the two groups are almost certainly conspecific. Other representatives of the zone have not been identified outside of Kansas. A single collection of dissepimental corals from the Wann Formation of Oklahoma resemble *Neokoninckophyllum variabile* COCKE, n. sp. This unit has been correlated by OAKES (1940) with Stanton limestones of Kansas and contains the fusulinid *Kansanella osagensis* which has not been reported from other units.

Fusulinids are common in the rocks of Zone 4. THOMPSON (1957) noted the presence of seven species in Wyandotte, Plattsburg, and Stanton rocks. *Kansanella tenuis,* which occurs below this zone in the Drum and Iola of Iowa and the Iola of Kansas, is also present in the Wyandotte of Iowa where it is accompanied by *Dibunophyllum parvum?*. *K. plicatula?* and *K. plicatula* are from the Farley Limestone, Wyandotte Formation of Kansas and Spring Hill Limestone of Kansas respectively and may also occur in the Oquirrh Formation of Utah (THOMPSON, 1957). Fusulinids of the Stanton Formation include *K. neglecta* from the Captain Creek Limestone of Kansas; *Triticites primarius* from the lower part of Stanton Rock Lake Shale of Kansas and *T. kawensis* from the upper part of the same unit in Kansas and Missouri and *T. newelli* from the South Bend Limestone of Kansas and Missouri. Subsequently, *T. primarius* and *T. newelli* have been identified by WADDELL (1966) in upper Missourian rocks of the Ardmore Basin. BILELO (1967, 1969) has identified *T. primarius* from the Winchell Formation of Texas.

Lophophyllid corals show promise in zonation of Midcontinent Missourian rocks. JEFFORDS (1942, 1947) studied several species of corals belonging to *Lophophyllidium, Stereostylus,* and *Lophamplexus.* Many of these are restricted stratigraphically within the Missourian and few extend into underlying Desmoinesian or overlying Virgilian rocks. Three species, *Lophophyllidium coniforme, S. pelaeus,* and *Lophamplexus vagus* are found both in Kansas and Oklahoma.

METHOD OF STUDY

The collections upon which this study is based were made over a five-year period, from 1964 to 1969, mostly on weekend trips and during field work for the Kansas Geological Survey on distribution of algal-mound complexes. However, the entire summer of 1965 was spent in collecting rugose corals, particularly in Wyandotte, Miami, Linn, and Bourbon Counties, Kansas. In addition, large numbers of dissepimental corals were given to me by P. H. HECKEL of the Kansas Geological Survey.

Several hundred transverse and longitudinal thin sections were prepared from Kansas Missourian corals. In addition, many forms from equivalent stratigraphic intervals of Oklahoma, Missouri, and Iowa were sectioned for comparison. Few seemed to be conspecific, and they will not be discussed in this paper. Early ontogenies of a few species were examined by using camera-lucida drawings of polished transverse surfaces.

Morphological terminology is consistent with that of MOORE, HILL & WELLS (in HILL, 1956). I have used the term "variant" in a completely informal sense to designate widely differing end members of a single species (see *Neokoninckophyllum kansasense* variant-1 and variant-2).

All type specimens have been assigned an SUI prefix and are placed in the Repository of the Geology Department, University of Iowa, Iowa City, Iowa.

SYSTEMATIC PALEONTOLOGY—ORDER RUGOSA

Family AULOPHYLLIDAE Dybowski, 1873

DIAGNOSIS

"Simple or less commonly compound Rugosa with numerous septa, a regular dissepimentarium, incomplete conical tabulae, and generally an axial structure. Septa are equally spaced and seldom curved about the small, open cardinal fossula, which is marked by extension of the tabularium into the dissepimentarium; major septa may be dilated in the tabularium, particularly in cardi-

nal quadrants; minor septa may be degenerate. Dissepiments are small and globose, concentric, angulo-concentric, or inosculating, rarely lonsdaleoid. The axial structure normally consists of straight or curved septal lamellae, commonly with a columella or median plate, and an inner series of tabellae." (HILL, 1956, p. *F*286).

REMARKS

The family Durhaminidae MINATO & KATO (1965a) is not recognized here, for it seems likely that the type genus, *Durhamina* WILSON & LANGENHEIM, is closely related to the neokoninckophyllids. In addition to the neokoninckophyllids included by MINATO & KATO in the family, *Clisiophyllum carnicum* HERITSCH (1936a) (=*Amandophyllum carnicum* HERITSCH, 1941), *Palaeosmilia schucherti* HERITSCH (1936b), *P. amfereri* HERITSCH (1936b), and *Dibunophyllum hessense* Ross & Ross (1962), the family includes the dibunophyllid genus *Amandophyllum* and a probable advanced dibunophyllid, *Yabeiphyllum* MINATO & KATO (1965a) of the *Dibunophyllum parvum* lineage of this report. For further remarks see Discussion after *Neokoninckophyllum* and the Evolutionary Trends section of this report.

Similarly, the family Waagenophyllidae WANG (1950) as discussed by MINATO & KATO (1965b) contains a wide range of morphological types including probable neokoninckophyllids (=*Huangia* YABE, 1950) and the geyerophyllid *Heritschiella* (MOORE & JEFFORDS, 1941). However, forms closely related to the type genus *Waagenophyllum* HAYASAKA (1924) are not observed in Kansas Missourian rocks.

Genus DIBUNOPHYLLUM Thomson & Nicholson, 1876

[*Dibunophyllum* THOMPSON & NICHOLSON, 1876, p. 457]

TYPE SPECIES.—*Dibunophyllum muirheadi* THOMSON & NICHOLSON, 1876, p. 462.

DIAGNOSIS.—Solitary rugose corals with cobweblike axial structure and well-developed dissepimentarium in ephebic stage. Minor septa are short, commonly not extending through inner limit of dissepimentarium. Major septa are long and somewhat crooked; within the dissepimentarium they are thin. The cardinal septum may be somewhat shorter than other major septa and lies in a small inconspicuous fossula. An inner wall, formed by stereoplasmic thickening of innermost dissepiments, separates the dissepimentarium from outermost tabulae. Tabulae are incomplete and anastomosing, nearly horizontal on the outer periphery of the tabularium but are more steeply inclined within the axial region. The columella consists of a median plate and radiating lamellae on either side. Generally, corallites are solitary and are conical in early stages but tend to become cylindrical. The epitheca is thin and crossed by growth lines and larger wrinkles but shows no evidence of longitudinal ribbing. (Diagnosis modified from HILL, 1938, p. 65).

DISCUSSION.—Lower Carboniferous dibunophyllid corals, typified by the type species, *Dibunophyllum muirheadi*, differ in several important respects from North American Pennsylvanian forms traditionally referred to the genus. The former possesses a distinct cardinal fossula, degenerate minor septa, and numerous major septa. Pennsylvanian dibunophyllids in North America have fewer major septa, show little evidence of fossulae, and possess strongly developed minor septa which commonly attain more than one-half the length of major septa. Lower Carboniferous forms are larger and many possess planar to peripherally concave tabellae in transverse section.

Several genera have been erected to include forms with dibunophylloid characters. *Arachnolasma* GRABAU (1922), from the Lower Carboniferous of China, differs from other solitary dibunophyllids in having a thinner axial structure with thickened median plate. *Corwenia* SMITH & RYDER (1926), Lower Carboniferous, is a fasciculate dibunophyllid with numerous thin major septa and short minor septa, dibunophylloid columella, and little evidence of an inner wall. YABE (1950) erected *Heritschioides* to include Lower Permian or Upper Pennsylvanian *Corwenia*-like fasciculate corals which differ from *Corwenia* in possessing dilated septa. In 1941, HERITSCH erected *Amandophyllum* for solitary Middle and Upper Carboniferous corals which closely resemble *Corwenia*. *Dibunophylloides* FOMICHEV (1953), from the Middle Carboniferous, includes solitary to weakly fasciculate dibunophyllids which possess strongly developed minor septa but no fossulae. DUNCAN (1962, p. 66) noted that some of the characteristics used to distinguish *Dibunophylloides* are observed in *Dibunophyllum (sensu stricto)*. In addition, FOMICHEV assigned corals which differed from *Dibunophylloides* in possessing lonsdaleoid dissepiments to *Sestrophyllum*. In a comprehensive study of Spanish Carboniferous corals, DEGROOT (1963) placed *Amandophyllum, Heritschioides, Dibunophylloides,* and *Sestrophyllum* in synonomy with *Corwenia*. Most corals studied here closely resemble *Dibunophylloides* in size, habit, number of major septa, and length of minor septa, but further study of dibunophyllids is necessary to determine validity of the above-cited genera.

In this paper, a broad interpretation of *Dibunophyllum* has been adopted to include solitary and fasciculate dibunophyllids with prominent minor septa but no fossulae, as well as those which possess these characters. This decision is based on observations that presence or absence of fossulae and minor septa may vary among individuals of a given species.

According to HILL (1956, p. *F*286) corals which have been assigned to six other genera should be included in *Dibunophyllum*: the names *Rhodophyllum, Aspido-*

TABLE 2. *Species Assigned to* Dibunophyllum *in North American Mississippian Rocks.*

SPECIES	REFERENCE	OCCURRENCE
D. lambii BELL	BELL, 1929, p. 95-96, pl. 4	Upper Visean, Chesteran, Nova Scotia
D. oregonense MERRIAM	MERRIAM, 1942, p. 373, pl. 54-55	Coffee Creek Formation, Chesteran, Oregon
D.? sp. A	SUTHERLAND, 1958, p. 85-86, pl. 30	Prophet Formation, Middle Mississippian, British Columbia
D.? sp. B	SUTHERLAND, 1958, p. 86, pl. 30	Middle? Mississippian, British Columbia
D. bipartitum konincki MILNE-EDWARDS & HAIME	ARMSTRONG, 1962, p. 41, pl. 5	Helms Formation, Chesteran, El Paso County, Texas

phyllum and *Cymatiophyllum* have priority, but HILL proposed the retention of *Dibunophyllum* because of widespread usage. Here the subjective synonym is questioned, allowing *Dibunophyllum* to be recognized as available and valid.

DISTRIBUTION OF DIBUNOPHYLLUM IN NORTH AMERICA

Until recently, dibunophyllid corals have been poorly known in North American Mississippian and Pennsylvanian rocks. Tables 2-5 list all published representatives of *Dibunophyllum* known to me; not included are forms referred to other genera but considered by me to be related to *Dibunophyllum* as interpreted herein. These include *Axophyllum rude* WORTHEN (1875) (WHITE, 1884; KEYES, 1894; BEEDE, 1900); *A.? alleni* ROWLEY (1901); *Lophophyllum alleni* GIRTY (1915)); *A. cylindricum* GIRTY (1915); and *A. infundibulum* GIRTY (1915) (in part). All of the above are from Pennsylvanian rocks of the Midcontinent; several, as customarily defined, have long geologic ranges. Although study of the following forms lies outside the area of study, it seems reasonable to consider *Heritschioides woodi* and *H. hillae* of WILSON & LANGENHEIM (1962) from Lower Permian beds of Nevada and *Heritschioides* Ross & Ross (1963) from Virgilian or Wolfcampian rocks of Texas as fasciculate forms closely akin to *Dibunophyllum* (see COCKE, 1966, 1969). JEFFORDS (1948b) discussed the distribution of dibunophyllids throughout Pennsylvanian Desmoinesian, Missourian and Virgilian rocks, as well as Permian Wolfcampian units; although *Dibunophyllum* is apparently not as widespread as envisioned by JEFFORDS, his paper is excellent.

Almost without question the cited corals do not represent all North American dibunophyllids referred to other genera, but documentation of such forms awaits further research. For a more extended discussion of Midcontinent Pennsylvanian dibunophyllids see COCKE (1966).

TABLE 3. *Species Assigned to* Dibunophyllum *from North American Pennsylvanian Morrowan and Desmoinesian Rocks.*

SPECIES	REFERENCE	OCCURRENCE
D.? inauditum MOORE & JEFFORDS	MOORE & JEFFORDS, 1945, p. 157-58, text-fig. 148a-d	Hale Formation, Morrowan, Oklahoma
D. moorei JEFFORDS	JEFFORDS, 1948a, p. 618-619, text-fig. 3-11	Oologah Formation, Desmoinesian, Oklahoma
D. moorei JEFFORDS	Ross & Ross, 1962, p. 1175, pl. 162	Gaptank Formation, Desmoinesian, Texas
D.? sp. A	Ross & Ross, 1962, p. 1176-1177, pl. 162	Gaptank Formation, Desmoinesian, Texas
D. moorei JEFFORDS	TISCHLER, 1963, p. 1064, pl. 141	Madera Formation, Desmoinesian, Colorado
D.? sp. A	ROWETT & SUTHERLAND, 1964, p. 67-68, pl. 9	Wapanucka Formation, Morrowan, Oklahoma
D. missouriense FRAUNFELTER	FRAUNFELTER, 1965, p. 6-7, fig. 1a-b	Higginsville Formation, Desmoinesian, Missouri

DIBUNOPHYLLUM HYSTRICOSUM Cocke, n. sp.

Figure 3; Plate 1, figures 2-3, 5-7

DIAGNOSIS.—Major septa reach approximately two-thirds across the corallite radius. They are thin and subcarinate in the dissepimentarium but thick in the tabularium. Minor septa are thin and equal to one-fourth to one-half of major septal length. Inner wall is obscure or missing. The columella is compact, with a highly spinose median lamella, numerous radiating lamellae, and closely packed tabellae which are peripherally convex at the outer edge but are barlike to axially convex near the center of the columella.

EXTERNAL CHARACTERS.—Because observed specimens are imbedded in limestone, little is known of their individual size and shape. Adult corallites are solitary, with moderately deep calices and low axial boss. Maximum diameter observed is 18 mm.

TRANSVERSE SECTION.—The septal number is 29 to 35 in ephebic stages. Major septal length is slightly less than two-thirds of the corallite radius. Septa are thin and extremely crooked to subcarinate in the outer dissepi-

TABLE 4. *Species Assigned to* Dibunophyllum *from North American Upper Pennsylvanian Missourian Rocks.*
[The listing given does not include new species described in this report; for those forms, see Table 1.]

SPECIES	REFERENCE	OCCURRENCE
D. valeriae NEWELL	NEWELL, 1935, p. 343-346, pl. 33	Stanton Formation, Missourian, Kansas
D. brucei COCKE	COCKE, 1966, p. 42-48, pl. 3	Dewey Formation, Missourian, Oklahoma
D. oklahomense COCKE	COCKE, 1966, p. 48-50, pl. 3	Dewey Formation, Missourian, Oklahoma
D. parvum COCKE	COCKE, 1969, p. 3-5, fig. 2	Wyandotte Formation, Missourian, Kansas

mentarium; maximum thickness is attained near the outer limit of the dissepimentarium with progressive thinning across the tabularium. Minor septa, ranging from one-fourth to one-half of major septal length, are crooked and extend to near the outer limit of the tabularium. The dissepimentarium consists of six to eight rows of dissepiments. Most outermost dissepiments are complete and peripherally convex. An obscure impersistent inner wall is present on innermost dissepiments in a few specimens. The tabularium consists of widely spaced outwardly convex plates and is equal to one-third of the diameter. The axial structure is typically dibunophylloid with three distinct regions, 1) a well-defined spinose median lamella which may be isolated or connected to either or both cardinal and counter septa, 2) 6 to 14 long irregular radiating lamellae and numerous short spinose lamellae, and 3) closely packed tabellae which are peripherally convex near the outer edge of the columella and are barlike to inwardly convex. Tabellae increase in number toward the columella center. Few radiating lamellae connect to major septa or the median lamella.

Figure 3 shows a badly silicified and abraded neanic section of *Dibunophyllum hystricosum* at a diameter of 1.8 mm. In addition to the thick counter-cardinal crossbar, 10 thickened major septa are present. Septal acceleration occurred in the alar quadrants resulting in a septal formula of C1A3K3A1. An earlier partial section suggests that this early acceleration does not occur adjacent to the alar septa but rather against two metasepta which lie on the counter side of each alar septum. This pattern differs from that of *D. brucei* COCKE (1966) in which the counter-cardinal crossbar forms first, followed in turn by insertion of two counter-lateral septa, two metasepta adjacent to the cardinal septum and lastly by two alar septa. The pattern is similar to that of *D. brucei* in that two metasepta are inserted adjacent to and on the cardinal side of the counter-lateral septa.

LONGITUDINAL SECTION.—The dissepimentarium consists of steeply inclined globose dissepiments with an average of 10 in 5 mm. An inner wall is developed on lower part of the corallite. The outer part of the tabularium is rimmed by short globose tabulae inclined at low angles against the outer dissepiments. Approximately 15 occur in 5 mm in contrast to 12 in 5 mm in the inner tabularium. Inner tabulae are gently inclined near the outer margin but steepen and grade axially to steeply inclined periaxial tabellae. Fourteen to 25 tabellae abut against the median lamella in 5 mm vertically. The median lamella is thin and crooked.

TABLE 5. *Species Assigned to* Dibunophyllum *from Upper Pennsylvanian (Virgilian) and Permian Rocks of North America.*

SPECIES	REFERENCE	OCCURRENCE
D.? sp.	MERRIAM, 1942, pl. 55, fig. 3	Coyote Butte Formation, Permian, Oregon
D. exiguum JEFFORDS	JEFFORDS, 1948a, p. 619-622, text-fig. 1-2, 11	Dover Limestone, Virgilian, Kansas
D. exiguum JEFFORDS	DUNCAN, 1962, p. 66, pl. 11	Dover Limestone, Virgilian, Kansas
Dibunophyllid coral	DUNCAN, 1962, p. 66, pl. 11	Red Eagle Limestone, Permian, Kansas
D. sp.	Ross & Ross, 1962, p. 1165, text-fig. 2	Gaptank Formation, Virgilian, Texas
D. hessense Ross & Ross	Ross & Ross, 1962, p. 1175-1176, pl. 162, 163	Lenox Hills Formation, Permian, Texas
D. sp. B	Ross & Ross, 1962, p. 1177-1178, pl. 163	Lenox Hills Formation, Permian, Texas
D. uddeni Ross & Ross	Ross & Ross, 1963, p. 415-416, pl. 49	Gaptank Formation, Virgilian, Texas
D. sp.	Ross & Ross, 1963, p. 416-417, pl. 48	Neal Ranch Formation, Permian, Texas
D. perplexum COCKE	COCKE, 1969, p. 7-9, fig. 2	Lawrence Formation, Virgilian, Kansas

DISCUSSION.—*Dibunophyllum hystricosum* differs from *D. bourbonense* COCKE, n. sp., in possessing more major septa, more radiating lamellae, and thinner median lamellae. It resembles *D. brucei* COCKE (1966) in having numerous major septa and long minor septa but differs in the spinose character of the columella. It can be differentiated from *D. exiguum* JEFFORDS (1948a) and *D. moorei* JEFFORDS (1948a) on the same basis. *D. brucei* has a less prominent median lamella and longer radiating lamellae.

MATERIAL STUDIED.—Fourteen specimens were collected from Locs. BF1 and BF6 in the Bethany Falls Limestone, Swope Formation, and Win2 and Win3 in the Winterset Limestone, Dennis Formation. Fourteen transverse and two longitudinal thin sections were prepared. Types are holotype SUI 33904 and paratypes SUI 33903 and SUI 33902.

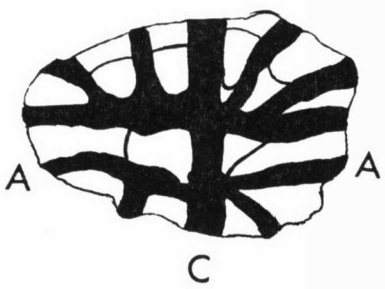


FIG. 3. Single transverse section in neanic stage of badly abraded and silicified specimen of *Dibunophyllum hystricosum* COCKE, **n.** sp., from the Bethany Falls Limestone at Loc. BF1. Shows cardinal-counter crossbar and 10 major septa; etched surface indicates a septal formula of C1A3K3A1, ×20. [*C*, cardinal septum; *A*, alar septum.]

DIBUNOPHYLLUM VALERIAE Newell, 1935

Figure 4; Plate 1, figures 8-13

Dibunophyllum valeriae NEWELL, 1935, p. 343-346, pl. 33.

DIAGNOSIS.—Slender to trochoid cylindrical corals in which a bladelike boss occurs in a well-developed calyx. Ephebic transverse sections exhibit 1) well-developed dissepimentarium approximately equal to one-third of the corallite diameter, 2) major septa considerably thickened in the tabularium, 3) a tabularium composed of gently curved tabulae, and 4) a well-developed columella composed of a moderately thick median lamella, numerous irregular radiating lamellae and closely packed, barlike to axially convex tabellae.

EXTERNAL CHARACTERS.—Individuals are ceratoid to cylindrical; known maximum height and diameter are 35 and 17 mm respectively. Fine, closely spaced growth lines traverse the epitheca. Major and minor septa extend upward to a short distance below the upper epithecal limit. The columella is bladelike and elongate in the counter-cardinal plane. All attachment areas observed are flattened subtriangular areas on the cardinal side of the corallite.

TRANSVERSE SECTION.—Approximately 27 to 32 major septa are present at diameters near 12 mm. The maximum of 34 septa occurs at 17 mm. Major septal length is approximately three-fourths corallite radius. Major septa are thin in the dissepimentarium. The septal formula is C7A7K7A7. Maximum thickness of major septa occurs at the outer dissepimentarium and progressive thinning across the tabularium produces obscure to pronounced lanceolate major septa. Within a single corallite, minor septa may be short triangular wedges or thin straight septa which reach approximately one-third major septal length. In most specimens, width of the dissepimentarium is slightly less than one-third of the corallite diameter. The outer two rows of dissepiments generally are complete, varying from axially to peripherally convex. On the innermost dissepiments, the thickness of the inner wall may be equal to one-fifth major septal length. A few scattered lonsdaleoid dissepiments have been observed in a few specimens from the Wyandotte and Stanton Limestones. The tabulae are barlike and smoothly curved plates which are gently convex both peripherally and axially. In most specimens, the columella is characterized by 1) a prominent median lamella which attains one-sixth of corallite diameter, 2) well-developed crooked radiating lamellae, and 3) closely packed barlike and axially convex tabellae. Specimens with fewer radiating lamellae also have tabellae which are more strongly curved.

One specimen of the species (SUI 33873) was suitable for ontogenetic study. The earliest known brephic section at a diameter near 1.3 mm possesses 7 major septa represented by a septal formula of C1AK1A1 (Fig. 4). The counter-cardinal crossbar is morphologically indistinguishable from other septa except for its continuation across the corallite. The epitheca is thick.

Higher sections show that 1) major septa are inserted on the counter side of the cardinal and alar septa, typically leaning against the adjacent primary septum; 2) thinner lateral septa are subparallel to the counter-cardinal crossbar and join the alar septa near their midpoint; 3) tabulae are inserted first near diameter of 2.0 mm; no minor septa or dissepiments are introduced.

At a diameter of 2.2 mm, in the highest section studied, the septal formula is C2A2K2A2.

LONGITUDINAL SECTION.—The dissepimentarium consists of four to six rows of dissepiments. They are small and gently convex with as many as 10 occurring in 5 mm along the epitheca in the ephebic stage. They are steeper along the inner and outer margins of the dissepimentarium and are thickened by stereoplasm to form an inner wall. The outer tabularium is formed by an impersistent row of tabulae which incline at low angles against the tabularium. Tabulae of the inner tabularium are long and irregular or convex upward. They are widely spaced and blend imperceptibly to the almost vertically inclined axial tabellae. The median lamella is crooked to sinuous in outline.

DISCUSSION.—The species is one of the longest ranging Missourian forms, being found in the Wyandotte, Plattsburg, and Stanton Formations. Generally, Wyandotte and Plattsburg individuals have major septa which possess a more distinct lanceolate character than those from the Stanton Limestone. Forms with strongly de-

veloped lanceolate major septa superficially resemble *Dibunophyllum parvum* Cocke (1969) but differ in possessing 1) septa which do not rise above upper limits of the epitheca, 2) larger size and more cylindrical shape, and 3) short minor septa which are not lanceolate.

Individuals assigned here to *Dibunophyllum valeriae* differ only in exhibiting more variation than shown in Newell's type specimens. Minor septa are more variable than noted by Newell, ranging from simple wedge-shaped protuberances on the epitheca to structures, in contrast to type material, which are equal to one-third of major septa length.

The holotype and some paratypes are from the Eudora Shale at NE cor. sec. 27, T. 24 S., R. 17 E., Woodson County, Kansas. The present condition of the exposure is extremely poor and efforts by me to collect topotypes were unsuccessful. Newell (1935, p. 346) noted that the types are in the geological museum of the University of Kansas, but I have been unable to locate them there and they may be presumed to be lost.

The early ontogenetic stages exhibited by a single specimen of *Dibunophyllum valeriae* are very similar to those described by Smith (1913) for *Aulophyllum fungites* (Fleming, 1828) from the Lower Carboniferous of the British Isles. Similarities include 1) presence of a counter-cardinal crossbar, 2) early insertion of alar and counter laterals, 3) great thickness of epitheca and septa until the columella begins to form, and 4) more or less simultaneous introduction of the columella, dissepimentarium, and minor septa. However, it differs in having septa of uniform thickness in all quadrants, in contrast to *A. fungites* which has thicker septa in the cardinal quadrants.

Material Studied.—More than 100 specimens have been collected from the Wyandotte, Plattsburg, and Stanton Formations at Locs. Wy1, Pb1, Pb2, Pb3, Pb4, Pb5, Pb6, Pb7, Pb8, Pb9, St1, St2, St3, St4, St8, St11 and St19. From these specimens, 52 transverse and nine longitudinal sections were prepared.

DIBUNOPHYLLUM BOURBONENSE Cocke, n. sp.

Plate 2, figures 1a-b, 2a-b

Diagnosis.—Small, ceratoid dibunophyllids comprise this species. The dissepimentarium is composed of several rows of steeply inclined, globose dissepiments, the innermost of which is thickened to form a distinct inner wall. The tabularium consists of loosely packed axially inclined plates, except along the outer margin of the tabularium where several tabulae with reverse inclination are present. Tabellae are less steeply inclined at the outer edge of the columella and grade laterally with tabulae. In transverse section, most tabellae are convex peripherally. The median lamella is particularly distinctive both in being thick and possessing small lateral protuberances.

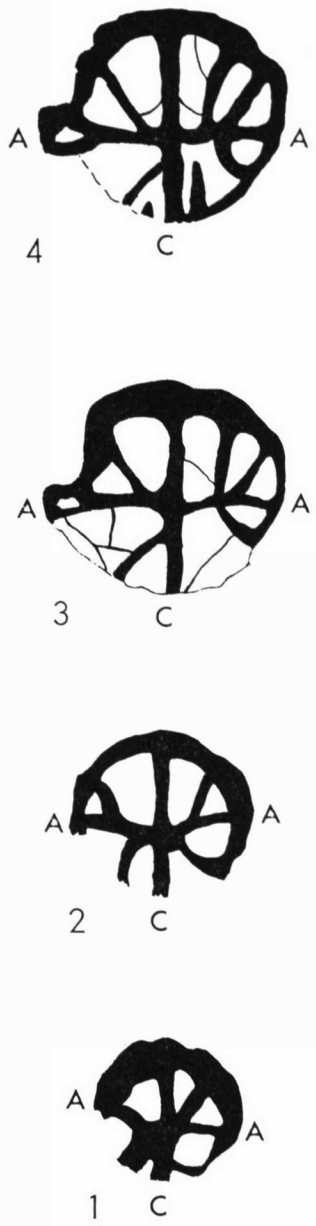


Fig. 4. Serial transverse section of a badly abraded specimen of *Dibunophyllum valeriae* Newell (1935) from Plattsburg Limestone at Loc. Pb1, all ×15.——*1*. Seven major septa present, including counter-cardinal crossbar; septal formula C1AK1A1.——*2*. Eight major septa with insertion of the second counter-lateral septum; septal formula C1A1K1A1.——*3*. Nine major septa with addition of one major septum on counter side of one alar septum; septal formula C1A1K2A1 (note introduction of several tabulae).——*4*. Insertion of major septa on each side of cardinal septum and one major septum on counter side of alar septum, resulting in 12 major septa; septal formula is C2A2K2A2. [*C*, cardinal septum; *A*, alar septum.]

Radiating lamellae are sparse and short. Few connect to the median lamella.

External Characters.—Specimens are small, ranging from 5 to 8 mm in diameter to 8 to 16 mm in length for incomplete specimens. They are commonly ceratoid. Two orders of transverse elements, fine growth lines and larger wrinkles are present. No specimens show rejuvenescence or budding. The calyx is moderately deep with a prominent boss. Attachment areas were not observed.

Transverse Section.—The epitheca is normally thin but in some specimens thickens slightly to form obscure internal ridges at its juncture with major septa. Major septa number 22 to 27. Typically, they are thin in the dissepimentarium but thicken abruptly at the inner edge of the dissepimentarium and progressively diminish in thickness across the tabularium. Minor septa are thin and equal one-fourth to one-third of major septal length. The width of the dissepimentarium is equal to one-third of the corallite diameter. The dissepimentarium is composed largely of irregular or peripherally convex dissepiments. Incomplete, axially convex dissepiments locally form herringbone patterns. The tabularium consists of loosely packed peripherally convex to irregular tabulae which grade axially into structures of the columella.

The columella is a moderately loose structure equal in width to one-third of the corallite diameter and consists of a median lamella, radial lamellae, and tabellae. The median lamella is thick, with a distinct median line and irregular protuberances along the sides. Where isolated from the cardinal and counter septa, its length is equal to one-fourth of the corallite diameter. A few short radiating lamellae are distributed among the tabellae, some abutting against the median lamella. Large, peripherally convex tabellae are concentrated along the median plate.

Late neanic sections show the median lamella connected to the cardinal and counter septa to form a crossbar, and also show fewer dissepimental rows.

Longitudinal Section.—The dissepimentarium is comprised of six to eight rows of small globular dissepiments. Most are inclined peripherally at an angle of 60 to 80 degrees and are particularly steep along the inner rim of the dissepimentarium. A distinct inner wall separates the dissepiments from the more gently inclined plates of the outer tabularium, which are convex distally and inclined axially at 5 to 45 degrees. In some specimens, a few tabulae along the inner wall have opposite inclination. In the lower portion of corallites tabulae are slightly steeper. The contact between the tabularium and columella is gradational.

One row of dissepiments is present at a diameter of 7.5 mm. Tabellae which abut against the thick irregular median lamella are inclined at angles up to 80 degrees. In addition to increased steepness, tabellae are smaller and more closely packed than tabulae.

Discussion.—Provisionally included in this species is a single specimen, SUI 33911, which differs from other members in the ephebic stage by less developed inner wall and lack of minor septa. A late neanic section, as well as a longitudinal section, show characters similar to those of other individuals of this species. Further study may clarify the taxonomic status of this specimen.

Girty (1915) described a specimen from the Hertha of Kansas City, Missouri, as *Axophyllum cylindricum,* which resembles *Dibunophyllum bourbonense* Cocke, n. sp. Members of the species as erected by Girty range from upper Desmoinesian to lower Virgilian rocks. Specimens labelled as "types" (apparently by Girty) are from the main ledge of the Virgilian Oread Limestone of Missouri, probably the Plattsmouth Limestone Member. They differ from the Hertha specimen in having 1) thinner major septa, 2) minor septa which may be absent in several major septal loculi, 3) a peculiar columella consisting of a short median lamella, relatively few radiating lamellae, and 4) an extremely narrow zone of closely packed tabellae. In addition, one specimen possesses a well-developed lonsdaleoid dissepimentarium. He assigned a morphologically similar form from the same locality (Girty loc. 423) to *A. infundibulum* Meek & Worthen (1875).

The species described here closely resembles *Dibunophyllum* sp. cf. *D. bourbonense* also from the Hertha, but differs in possessing a thinner median lamella and major septa which do not rise above the peripheral epitheca of the calyx. Both groups are separated from *D. hystricosum* Cocke, n. sp., of the Winterset Formation in possessing a thicker median lamella, shorter radiating lamellae, and more strongly convex tabellae.

Material Studied.—Specimens were collected from Locs. H1, H3, H7, and H8 in the Hertha Formation. Ten transverse and three longitudinal sections were prepared. The holotype is SUI 33910; paratypes are SUI 33909 and SUI 33908.

DIBUNOPHYLLUM sp. cf. D. BOURBONENSE Cocke, n. sp.

Plate 2, figures 3a-b

Diagnosis.—Small dibunophyllids in which the major septa rise above upper limit of the epitheca comprise this group. The major and minor septa are lanceolate. Minor septa are one-half as long as major ones. The dissepimentarium is slightly less than one-half of the corallite diameter. The columella is compact, almost circular, and has a thick barlike median lamella. Radiating lamellae are short; tabellae are strongly convex outward and widely spaced.

External Characters.—Moderately flaring dibunophyllids with transversely wrinkled epitheca are included in this species. Maximum length and diameters of 10 and 13 mm respectively are present in a single specimen, SUI 33907; most specimens are considerably smaller.

Attachment areas are small, irregularly triangular, and present only on convex side of corallites. In the outer calyx, septa rise slightly above the upper limits of the epitheca. A cylindrical boss is slightly elongated in the plane of curvature.

Transverse Section.—The epitheca is thin but thickens to form faint internal ridges at major and minor septal junctures. In high ephebic stage, 22 to 25 major septa cross three-fifths of the corallite diameter. The septal formula is C5A5K6A5. Few major septa unite with radiating lamellae of the columella. Both orders of septa are thin at the epitheca, thicken gradually to reach the maximum at the inner wall and progressively decrease in thickness in the tabularium. Minor septa attain approximately one-half of major septal length. The dissepimentarium is slightly less than one-half as wide as the corallite diameter. It is comprised largely of incomplete, axially convex dissepiments, which are arranged *en echelon* along the sides of septa or in herringbone pattern across septal loculi. Stereoplasmic deposits form an obscure inner wall on innermost dissepiments. A few long peripherally convex plates cross the tabularium; axially they are indistinguishable from tabellae of the columella.

The columella is a compact structure which is almost circular and only slightly elongated in the cardinal-counter plane. The ellipsoidal median lamella is very thick; its width is approximately one-half its length. Small sharp protuberances create a burlike effect. Radiating lamellae are short; few adjoin the median lamella. Tabellae are strongly convex outward, widely spaced, and slightly thickened by stereoplasmic deposits.

In late neanic stage, the median lamella is connected to the cardinal and counter septa. Major and minor septa are considerably thickened. Tabellae and dissepiments are smaller and less numerous than in higher stages.

Discussion.—*Dibunophyllum* sp. cf. *D. bourbonense* Cocke, n. sp., resembles the Wyandotte and Lansing *D. parvum* Cocke (1969) in 1) possessing two orders of septa which rise above epithecal limits, 2) similar shape of major and minor septa, and 3) general composition of the columella and dissepimentarium. It differs in having less well-developed lanceolate septa, no septal carinae, and a much thicker median plate. The similarities between *D. parvum* and *D.* cf. *D. bourbonense* suggest that the former may have arisen from the latter by intensification of the lanceolate character of the major septa and by thinning of the median lamellae. However, links between the Hertha species and *D. parvum* if present, have not been discovered.

Dibunophyllum sp. cf. *D. bourbonense* differs from *D. bourbonense* in possessing sublanceolate to lanceolate septa that rise above the upper limit of the epitheca and a stouter median lamella.

Material Studied.—Eight specimens were collected from Loc. H10. Two transverse and two longitudinal sections were prepared. Figured specimens are SUI 33906 and SUI 33905.

DIBUNOPHYLLUM CLATHRUM Cocke, n. sp.

Plate 2, figures 4a-b, 5a-b

Diagnosis.—Small conical solitary to budding corallites comprise this species. Major septa which reach halfway across corallites are thickest near mid-point. Minor septal length ranges from one-fourth to one-half major septal length. The dissepimentarium is one-third as wide as corallite diameter. Stereoplasmic thickening creates a prominent inner wall. The columella consists of a pronounced median lamella, tabellae, and rare radiating lamellae.

External Characters.—Corallites are small, with maximum length and width of 8.5 and 8.0 mm respectively. Most are solitary but a few have as many as three buds in the calyx. They are conical throughout and curved only in the apical region. The calyx is moderately deep, with a moderately stout axial boss which is commonly somewhat elongate in the counter-cardinal plane. Both major and minor septa are visible in the calices. The epitheca is crossed by many fine growth annulations. No rejuvenated forms have been collected. The small triangular attachment area lies on the convex cardinal side of curvature.

Transverse Section.—The 22 to 26 major septa extend from the epitheca across approximately one-half of the corallite diameter. The moderately robust septa are thicker near the mid-point and thin toward both ends. Minor septal length ranges from one-fourth to one-half of major septal length. The dissepimentarium is approximately one-third as wide as the corallite diameter, consisting of complete barlike and peripherally convex dissepiments in areas where minor septa occur. Inwardly incomplete, axially convex dissepiments are most common; however, near the inner limit of the dissepimentarium peripherally convex complete and incomplete dissepiments are common. Stereoplasm is deposited on innermost dissepiments. Large, smooth, peripherally convex tabulae grade axially to more closely packed tabellae of the columella. A prominent median lamella is commonly attached to either or both counter and cardinal septa. Few radiating lamellae are present. In a single aberrant specimen (SUI 33901) both major septa and minor septa, as well as the inner wall, approximately double in thickness and the columella is almost a solid structure.

Longitudinal Section.—Dissepiments are generally uniform in size and incline at angles near 45 degrees. The innermost dissepiments are thickened to form a prominent inner wall. Approximately 7 occur in 5 mm along the epitheca. Outermost tabulae are gently curved and inclined in the same direction as are the dissepi-

ments but at lower angles. Inner tabulae are globose, and more steeply inclined toward the axis. Progressive steepening axially results in almost vertical tabellae in the center. The median lamella is solid and varies little in thickness vertically.

Discussion.—Presence of spinose median lamellae and more numerous radiating lamellae separate *Dibunophyllum hystricosum* and *D. bourbonense* Cocke, n. sp. from the species described here. *Dibunophyllum* sp. cf. *D. bourbonense* has a thicker lamella. In addition to its consistently smaller size, the species studied differs from *D. brucei* in possessing fewer radiating lamellae, a more narrow dissepimentarium and shorter minor septa.

Material Studied.—Approximately 50 specimens were collected from Locs. Dr1 and Dr2 in the Cement City Limestone. Eighteen transverse and five longitudinal sections were prepared. The holotype is SUI 33900 and paratypes are SUI 33899 and SUI 33898.

DIBUNOPHYLLUM ELEGENTE Cocke, n. sp.

Plate 2, figures 12a-b, 13

Diagnosis.—The species is composed of gregarious or perhaps loosely colonial individuals. Specimens are conicocylindrical with moderately deep calices with low central bosses. Major septa are thin and sinuous to thinly lanceolate. Where present, minor septa are one-fifth to one-third of major septal length. The dissepimentarium, which is one-third to one-half corallite diameter, is highly variable, consisting largely of complete peripherally convex or closely packed incomplete axially convex dissepiments. An inner wall separates the tabularium and dissepimentarium. The columella consists of a median lamella which is generally connected to the cardinal and counter septa and variable numbers of radiating lamellae among peripherally convex tabellae.

External Characters.—All specimens are enclosed in calcilutite matrix. However, evidence suggests that 1) individuals are solitary but gregarious and conicocylindrical, 2) the epitheca has no longitudinal ribbing, and 3) the calyx is deep, with a low boss. Maximum length and diameter observed are 24 and 10 mm respectively.

Transverse Section.—At diameters of 8 to 10 mm, 19 to 21 major septa are counted. They cross two-thirds to three-fourths of the corallite radius and are thin and crooked to thinly lanceolate. Minor septa are present in most septal loculi where they are one-fifth to one-third of major septal length. Width of the dissepimentarium ranges from one-third to one-half of corallite diameter. Two forms of intergrading dissepimentaria are recognized: 1) a zone of closely packed axially convex and dependent dissepiments, and 2) a band of moderately spaced peripherally convex dissepiments.

An inner wall commonly separates the dissepimentarium and tabularium. The latter is approximately one-third of the corallite diameter and consists of widely separated barlike, peripherally convex and axially convex tabulae. The columella consists of a median lamella which is commonly connected to both counter and cardinal septa, and a variable number of radiating lamellae distributed among peripherally convex tabellae.

Longitudinal Section.—The dissepimentarium comprises a peripheral zone approximately equal to one-third of the corallite diameter. Four to six rows of small globose dissepiments are present with 10 to 15 in 5 mm vertically. Many are thickened by stereoplasm. Outer dissepiments are inclined at 45 degrees. They steepen toward the inner margin of the dissepimentarium where most are nearly vertical. The innermost row forms an obscure inner wall. The tabularium is composed of distally convex anastomosing tabulae which are inclined peripherally along the outer edge and axially inclined along the inner margin. In the center of the tabularium many tabulae show little or no inclination.

In the upper part of the corallite the columella comprises one-fourth of the corallite diameter; in the proximal region it is less than one-fifth of this diameter. It consists of a distinct sinuous median lamella, closely packed, steeply inclined tabellae and intersected ends of radiating lamellae.

Discussion.—This species differs from all Missourian dibunophyllid corals in the absence of minor septa in some major septal loculi, in the compact nature of the columella in longitudinal section, and in connection of the median lamella to the cardinal and counter septa even in apparently late ephebic stage.

Material Studied.—Approximately 40 specimens were collected from Loc. I2, from which seven transverse and three longitudinal sections were prepared. The holotype is SUI 33894 and two paratypes are SUI 33893 and SUI 33892.

DIBUNOPHYLLUM PARVUM Cocke, 1969

Plate 2, figures 8a-b, 9, 10, 11a-b

Dibunophyllum parvum Cocke, 1969, p. 3-5, fig. 2,*1-3*.

Diagnosis.—Small, turbinate dibunophyllids in which well-developed lanceolate septa generally rise above epitheca comprise this species. The epitheca is crossed by fine loosely spaced growth lines. A few specimens have one to three small corallites in calices. Ephebic stages have well-developed, dibunophylloid columella and regular dissepimentarium; major septa number 22 to 24 and are slightly thickened in cardinal quadrants. Innermost tabulae blend with more steeply inclined tabellae of columella.

External Characters.—This species consists of small turbinate corals, in which diameters range from 2 to 11.5 mm. The epitheca is crossed by fine transverse growth lines and smooth wrinkles. Several corallites have three or four rejuvenescent stages, and a lesser number have

as many as three small corallite buds. Calices are deep, with septa commonly rising as much as 0.5 mm above upper limit of the epitheca; a prominent, seemingly solid axial boss commonly rises to a slightly lower position. The columella is bladelike, with the plane of its long axis approximately bisecting the attachment area. Flattened triangular to quadrate attachment areas are slightly less than one-half the length of the corallites and the maximum widths equal one-third the diameter.

Transverse Section.—The epitheca is thin, commonly with local internal ridges corresponding in position to peripheral ends of septa. The major septal number ranges from 22 to 24. Septa are thin and crooked near the outer wall, increase gradually to maximum thickness near the inner wall, and thin into the tabularium. Major septal length is equal to two-thirds of the corallite radius; few major septa connect to radiating lamellae of the columella. Minor septa are one-half to four-fifths length of major septa; they are similar to major septa but slightly thinner. Fossulae are not present. Dissepimentaria comprise three to five thin, commonly complete dissepiments which are generally convex outward; complete dissepiments which are planar or curve inward are common. Particularly in areas of increased septal thickening, dissepiments are irregular, incomplete, or have ends affixed to a single septum. The dissepimentarium occupies one-third to one-half of the corallite diameter. Innermost dissepiments are thickened locally to form an obscure inner wall. The tabularium occupies less than one-fourth of the diameter and is composed of thin tabulae which commonly are planar or slightly convex peripherally.

The oval to subcircular columella consists of a median plate, radiating lamellae and tabellae, and it comprises one-fifth to one-fourth of the corallite diameter. The median plate is thick and usually rimmed by large tabellae. Except in rare specimens, the radiating lamellae are short and isolated among tabellae, neither connecting to major septa nor abutting against the median plate. At diameters of 2.5 to 3.0 mm, 12 to 14 major septa are present; they are thin, slightly thickened in the cardinal quadrant, and extend into the tabularium. A cardinal-counter septum crosses the corallite and minor septa are thin and equal to less than one-half of major septal length. The dissepimentarium is composed of a row of peripherally convex plates which are structurally similar to both tabulae and tabellae. The central area is filled with globular plates which blend with the tabulae. No radiating lamellae have been observed at this stage.

Longitudinal Section.—An obscure inner wall is formed on the inner row of dissepiments. Short subhorizontal tabulae rim more steeply inclined long plates which merge with the closely packed gently inclined tabellae of the axial structure. A moderately thick median lamella occupies the central position.

Discussion.—This species is somewhat similar to *D.* sp. cf. *D. bourbonense* Cocke, n. sp., from the Missourian Hertha Formation in possessing septa which rise above the upper limits of the epitheca and in having lanceolate major septa. (For more complete coverage see discussion of *D.* sp. cf. *D. bourbonense*.)

Dibunophyllum parvum ranges from near the base of the Wyandotte Formation to the middle of the Stanton Formation. Major and minor septa become increasingly more lanceolate and carinate in progressively younger rocks. Separation into discrete species has not been made because of this intergradation. *Dibunophyllum dibolium* Cocke, n. sp., from the upper part of the Stanton Formation is similar to this species and perhaps is an advanced species of the same lineage. It differs in the presence of an outer dissepimentarium composed of axially inclined dissepiments as well as a semi-aulophylloid columella. *Dibunophyllum* sp. A Stewart (1961, unpublished master's thesis) from Missourian Wolf Mountain Limestone of Texas closely resembles *D. parvum* and is probably conspecific with it. A small dibunophyllid closely resembling *D. parvum* has been collected from a limestone buildup in the Wann Formation of Oklahoma, which is in part stratigraphically equivalent to the Plattsburg and Stanton Formations. Corals from the Argentine? Limestone of Iowa are very similar to *D. parvum*.

Individuals of *D. perplexum* Cocke (1969) from the lower Virgilian Amazonia Limestone of the Lawrence Formation resemble *D. parvum* closely but differ in characters of the central area which may have 1) either a dibunophylloid columella or 2) widely spaced subhorizontal tabulae or 3) a combination of these.

Material Studied.—Approximately 300 specimens were collected from basal beds of the Argentine Limestone, Wyandotte Formation, at Loc. Wy3. Other localities in the Wyandotte are Wy1, Wy2, Wy5, Wy6, Wy7, Wy8, Wy9, Wy11, and Wy12. Specimens have been collected from the Plattsburg Limestone at Locs. Pb1, Pb2, Pb3, Pb4, and Pb6. Stanton representatives are from St5, St14, St16, St17, St18, St19 and St28. Over 100 transverse and 30 longitudinal sections were studied in preparing description of the species. The holotype KUMIP no. 500515 is reposited at the University of Kansas Museum of Invertebrate Paleontology.

DIBUNOPHYLLUM DIBOLIUM Cocke, n. sp.

Plate 2, figures 6a-c, 7

Diagnosis.—This species consists of individuals in which major septa rise noticeably above upper limits of the epitheca. Lanceolate major septa are thin and extremely crooked in the dissepimentarium but become very thick a short distance axially from the septal midpoint. Minor septa have shapes similar to major ones and reach two-thirds to three-fourths of major septal length. In transverse section, outer dissepiments are

angulate with apices directed axially. In longitudinal section, these outer dissepiments are inclined toward the corallite center, in contrast to opposite inclination of other dissepiments. Inner dissepiments are highly diversified in transverse section. An obscure inner wall is formed on innermost dissepiments. Close packing of numerous radiating lamellae and tabellae characterize the columella.

External Characters.—Most specimens have heights and widths near 6 and 5 mm respectively. The epitheca is thin and marked by two orders of transverse elements, low smooth wrinkles and closely spaced growth lines. Major and minor septa rise approximately 1 mm above upper limits of the epitheca. The columella is a low broadly oval structure with curved lamellar ridges. No attachment areas were noted.

Transverse Section.—Major septa number 22 to 27 near the base of the calyx. The outer one-third of each such septum is thin, commonly denticulate and crooked. The central part is swollen; the maximum thickness is located a short distance axially from the septal mid-point. Major septa thin to a needle point at a distance equal to two-thirds of the corallite radius. Minor septa which have shapes similar to those of major ones are three-fourths of major septal length in the calyx and approximately two-thirds of this length in late neanic stages. The dissepimentarium is composed of a highly diversified array of dissepiments. Outer dissepiments tend to be angulate with apices directed inward. Axially, most are dependent, septal or complete to incomplete axially convex plates. An obscure impersistent inner wall is formed by stereoplasmic deposits on innermost dissepiments. The columella is broadly oval, consisting of very closely packed tabellae and as many as 25 radiating lamellae abutting against a long thin median lamella. In the calyx, the columella is approximately equal to one-third of the corallite diameter.

In early neanic stages, at diameters near 4 mm, major septa are present. Several are connected to radiating lamellae of the columella. Details of the columella are obscured somewhat by heavy deposits of stereoplasm.

Early neanic stages exhibit fewer and thinner skeletal elements and most dissepiments are complete, irregular, and more widely spaced than in later stages.

Longitudinal Section.—This species possesses the most distinctive and varied dissepimentarium of any known North American dibunophyllid. The outer dissepiments are lath-shaped to slightly curved upward, forming a vertical herringbone pattern against the epitheca and inner dissepiments. Three gradational series of globular dissepiments comprise the inner dissepimentarium: 1) an outer zone of axially inclined medium-sized dissepiments, 2) a middle zone of weakly inclined to horizontal large globular dissepiments, and 3) an innermost zone of extremely steep small dissepiments. The tabularium consists of upwardly convex axially inclined tabulae alternating with similar but peripherally inclined tabulae. The plates grade into the smaller slightly more inclined tabellae of the columella. The columella is composed of very closely spaced elongate tabellae and ends of intercepted radiating lamellae.

Discussion.—The form described here is somewhat intermediate between *Dibunophyllum parvum* Cocke of the Missourian Wyandotte and Plattsburg Formations and *D. perplexum* Cocke from the Virgilian Amazonia Limestone. It resembles the former in persistence and general nature of the columella but differs in possessing more highly developed lanceolate septa and lateral septal spines. In these characters it resembles *D. perplexum*. It differs from both species in having an outer dissepimentarium of axially convex and peripherally inclined angulate dissepiments.

Material Studied.—Forty-six specimens were collected from the South Bend Limestone, Stanton Formation, at Locs. St11, St23, and St26. The holotype is SUI 33897 and paratypes are SUI 33896 and SUI 33895.

Genus NEOKONINCKOPHYLLUM Fomichev, 1939

[*Neokoninckophyllum* Fomichev, 1939, p. 352]

Type Species.—*Neokoninckophyllum vesiculosum* Fomichev, 1939.

Diagnosis.—"Solitary corallites of elongate subcylindrical form, having a well-developed dissepimental zone at the periphery, an inner area of up-arched irregular tabulae, an indefinite axial column that lacks a distinct weblike appearance in transverse section, and numerous subequal long major septa may be identified as representatives of *Neokoninckophyllum*. The theca is thin, its exterior bearing transverse wrinkles and growth lines but lacking septal grooves. The major septa are mostly thin, evenly disposed, and long. Some of them, especially the counter septum, reach to the axis of the corallite, but the majority terminate inward just short of the rather indefinite axial column. No fossulae are developed. The minor septa are short, being confined to the dissepimental zone, or they may not be present. In some specimens the outer parts of the septa tend to weaken, becoming discontinuous or disappearing. The inner parts may be somewhat thickened by stereoplasm. The dissepimental zone is moderately wide, and the inner margin, which is even or uneven, is not thickened to form a well-marked wall. Individual dissepiments range in size from very small to large, their surfaces convex toward the interior of the coral and sloping steeply downward. In transverse sections, the dissepiments appear very irregular in position, mostly running obliquely rather than normal to the septa. Lonsdaleoid structure is developed in the dissepimental zone where the septa disappear. The tabulae are very numerous, uneven, and anastomosing. They slope gently or with moderate steepness upward from their

outer edges toward the axis. An axial column consisting of irregular vertical lamellae and upturned inner margins of the tabulae is observed, but there is no clearly defined median lamella or somewhat evenly disposed radiating lamellae, as in *Dibunophyllum*." (MOORE & JEFFORDS, 1945, p. 158.)

DISCUSSION.—ROWETT & SUTHERLAND (1964) utilized *Koninckophyllum* THOMSON & NICHOLSON (1876) for Lower Pennsylvanian corals of Oklahoma. According to HILL (1938, p. 86) this genus consists of: "Simple or dendroid Rugose corals with clisiophylloid septa and *fossula*; the major septa are withdrawn from the axis except along the surface of the tabulae, *the minor septa long*; the tabulae are tentshaped, and dissepiments fine and concentrically arranged; a styliform columella is present. Diphymorphs may occur." (HILL, 1938, p. 86; italics by me.)

FOMICHEV (1939) erected the genus *Neokoninckophyllum* for Middle or Upper Carboniferous *Koninckophyllum*-like corals which differ from that genus in lacking fossulae and minor septa or possessing only very short minor septa. Separation of the two genera is arbitrary to some extent and further research on corals of intermediate age between *K. magnificum*, type species of that genus, and *N. vesiculosum* may show the two genera to be intergradational. Because most Missourian species either lack a fossula or show characters of the minor septa similar to those of *Neokoninckophyllum* the validity of the genus is here recognized.

DISTRIBUTION OF NEOKONINCKOPHYLLUM IN NORTH AMERICA

A possible North American Mississippian representative of *Neokoninckophyllum* is *Koninckophyllum talonatum* EASTON (1943) from the Chesteran Pitkin Limestone of northern Arkansas, which resembles *Neokoninckophyllum* in external characters, lack of both minor septa and fossula, and in characters of the tabulae. Further study of the species must be completed before reassignment to *Neokoninckophyllum* is made. Mississippian corals from the Kinderhookian Chouteau Formation of Missouri assigned to *K. glabrum* (KEYES, 1894) by EASTON (1944) seem to belong to *Koninckophyllum (sensu stricto)*. *Koninckophyllum?* sp., described by EASTON (1962) from Mississippian rocks of Montana, appears to be an aberrant caninioid which, in addition to possessing caniniid characters of cyathopsid thickening of major septa and distinct cardinal fossula, also exhibits a well-developed lonsdaleoid dissepimental zone. ARMSTRONG (1962) described the new species *K. elpasoense* from the Helms Formation (Chesteran) of Texas. It is very similar to *K. nitellum* (MOORE & JEFFORDS, 1945; see discussion below).

Neokoninckophyllum is well represented in Lower Pennsylvanian rocks of northeastern Oklahoma and central Texas by *N. simplex, N. arcuatum, N. gracile,* and *N.* sp. A, all of which were described by MOORE & JEFFORDS (1945). Species described by these workers and assigned to *Pseudozaphrentoides lepidus, P. nitellus, Rodophyllum texanum,* and *Dibunophyllum? inauditum* may belong to *Neokoninckophyllum*. ROWETT & SUTHERLAND (1964) assigned *Pseudozaphrentoides nitellus* to *Koninckophyllum*. Additionally, they assigned other Lower Pennsylvanian neokoninckophyllids of central Oklahoma to the same genus. These include a new species, *K. oklahomense,* as well as *K. simplex* (MOORE & JEFFORDS). Representatives of *K. nitellum* differ from other Morrowan forms described by MOORE & JEFFORDS and by ROWETT & SUTHERLAND in possessing well-developed minor septa, and may be referred to *Koninckophyllum (sensu stricto)*.

The genus has not been described from Atokan or Desmoinesian rocks of the Midcontinent. However, Ross & Ross (1962) described *Neokoninckophyllum dunbari* from Desmoinesian rocks of the Glass Mountains of Texas. No known representatives of the genus have been described from Missourian units prior to this report.

Neokoninckophyllids are abundant in several units in the Missourian of Kansas (Table 1). In addition, I have collected probable representatives of the genus from two Missourian formations, the Wann and Hogshooter of northeastern Oklahoma and a lower Canyon (Missourian) unit in north-central Texas.

Virgilian rocks of Kansas contain abundant elongate forms which JEFFORDS placed in *Dibunophyllum*. Although the few specimens that have been cut seem to be related to the dibunophyllid *Axophyllum cylindricum* (GIRTY, 1915) it is likely that many are related to *Neokoninckophyllum*. A single species, *N. cooperi* Ross & Ross (1962) has been described from lower Virgilian beds in the Glass Mountains, Texas. My collections from the Graham Formation, Virgilian, of north-central Texas contain several forms which may be assigned to the genus.

Little is known of the genus in Permian rocks; however, extensive collecting for Rugosa has not been undertaken. It may be represented by a colonial form referred to *Dibunophyllum* (HATTIN, 1957) in the Wolfcampian Wreford Formation of Kansas. *Palaeosmilia schucherti* (HERITSCH, 1936b) collected from Wolfcampian Saddle Creek Limestone of Texas shows several similarities to *Neokoninckophyllum* but its affinities remain uncertain. *Neokoninckophyllum deciense* has been described from Permian Wolfcampian rocks of west Texas by Ross & Ross (1962). *Durhamina cordillerensis* (EASTON, 1960) from the Wolfcampian and Leonardian of Nevada is a fasciculate coral closely related to *Neokoninckophyllum* as interpreted here.

In placing corals with a wide range of morphological characters in *Neokoninckophyllum,* I am cognizant of probable criticism but request that critics examine the

range of variability shown in an individual of a species, between individuals of a given species, and between individuals of different species.

NEOKONINCKOPHYLLUM PETILUM Cocke, n. sp.

Plate 2, figures 14a-b, 15, 16, 17a-b

DIAGNOSIS.—Specimens are small and apparently conicocylindrical. Major septa are thin, number 19 to 22, and reach across four-fifths of the corallite radius. The loosely packed dissepimentarium is composed of steep, axially convex incomplete and septal dissepiments. An inner wall is present in most specimens. The columella consists of a barlike extension of major septa surrounded by tabulae; rarely a few radiating lamellae are present. In longitudinal section the central area is filled with moderately steep domal tabulae and irregular septal lamellae.

EXTERNAL CHARACTERS.—All specimens collected were fragmented, and imbedded in dense calcilutite; hence only general external features are known. Because no longitudinal ridges and grooves are present on transverse section, it is assumed that the epitheca is crossed only by transverse growth annulations. Maximum diameter is 8 mm. Corallites are apparently conicocylindrical.

TRANSVERSE SECTION.—The number of major septa is 19 to 22 at diameters near 8 mm. Major septal length is approximately equal to two-thirds of the corallite radius. Septa are extremely thin near the periphery. They thicken at the mid-point and progressively thin to terminate at a point approximately equal to four-fifths of the corallite radius. Gentle undulations occur along the length of the septa. No minor septa have been observed. The dissepimentarium is characterized by thinness and loose packing of globose dissepiments; in addition, the majority of dissepiments are either incomplete and convex axially or septal (i.e., both ends of the dissepiment abut against a single septum). The dissepimentarium in forms possessing an inner wall is equal to approximately one-third to one-half major septal length. Angulate lonsdaleoid dissepiments occur sporadically in a few specimens. The gradational nature of the dissepimentarium and tabularium in many transverse sections prohibits width determination of the former. Most specimens have a single thin bar which extends to the corallite center and is generally connected to a major septum, presumably the counter septum. The bar is surrounded by peripherally convex tabulae and in some instances short irregular lamellae. A few corallites show no evidence of a columella in transverse section.

LONGITUDINAL SECTION.—In the upper part of corallites studied three to six rows of dissepiments comprise the dissepimentarium. Dissepiments are variable in size with as many as 17 occurring in 5 mm along the epitheca. Most are inclined at an angle in excess of 45 degrees. A distinct inner wall is observed in many specimens. Along the outer margin of the tabularium, blocky tabulae may be inclined against the inner wall. The inner domal tabulae progressively steepen toward the corallite center. Discontinuous and continuous lamellae combine with these steeply inclined tabulae to form a loosely packed axial structure. Where septal lamellae are absent, tabulae are widely spaced and sag axially or are gently convex upward.

DISCUSSION.—Lack of satisfactory material in this species makes specific assignment difficult. However, the rather distinctive dissepimentarium and columella are used here in separating this species from other neokoninckophyllids. Presence of a distinct inner wall and columella in most specimens, incomplete globose dissepiments, and lack of minor septa in all sections separates the species from *Neokoninckophyllum acolumnatum* COCKE, n. sp., which it resembles in size and packing of structural elements.

MATERIAL STUDIED.—Several fragments were collected from the Block Limestone, Cherryvale Formation at Bk1; six transverse and four longitudinal thin sections were prepared. Holotype is SUI 33884 and paratypes are SUI 33883 and SUI 33882.

NEOKONINCKOPHYLLUM KANSASENSE (Miller and Gurley, 1893)

Figures 5-6; Plate 3, figures 1a-c, 2, 3, 4a-b, 5, 6a-b, 7a-b, 9a-b, 10

Campophyllum kansasense MILLER & GURLEY, 1893, p. 67-68, pl. 7, fig. 19-22.——WELLER, 1898, p. 161.

Axophyllum? sp. D GIRTY, 1915, p. 315-316.

Bothrophyllum? kansasense EASTON, 1944, p. 123, pl. 22, fig. 8-10.

DIAGNOSIS.—*Neokoninckophyllum kansasense* is a highly variable species. All individuals possess major septa which reach two-thirds to three-fourths across the corallite radius. Minor septa are short and may be common only in early stages. A weak columella may form as a result of union of major septal ends. The tabularium is wide and consists of convex plates. Most dissepiments in transverse sections are incomplete and convex inward. Two somewhat artificial end members are recognized. The smaller, here referred to *N. kansasense* var. 1, consists of subcylindrical individuals which possess a narrow dissepimentarium of moderately packed, axially convex dissepiments; tabulae are gently convex upward and moderately spaced. The other group, here referred to *N. kansasense* var. 2, consists of large ceratoid to subcylindrical forms which generally differ from other representatives of the species in possessing a proportionately wider dissepimentarium consisting of highly variable dissepiments. Most dissepiments are very small, closely packed, axially convex and incomplete; lonsdaleoid dissepiments are present in some individuals. The tabularium generally consists of closely spaced, highly rounded tabulae. Generally, the two variants are some-

what geographically isolated although intermediates are known at all localities.

External Characters.—Externally, two intergrading types are recognized: 1) small subcylindrical forms with diameters and heights of 10 and 40 mm respectively; 2) ceratoid forms which may reach diameters and heights near 24 mm and 50 mm. These are referred to *N. kansasense* var. 1 and var. 2 respectively. Included in the second group are small broadly flaring individuals with heights which range between 4 and 6 mm and diameters near 15 mm. In all forms, the epitheca is traversed by small, closely spaced growth lines. Rejuvenescence is common only in larger individuals. Calices are shallow and cylindrical to broadly conical in all subcylindrical and ceratoid forms. In broadly flaring corallites, the calyx is shallow. A low central boss marked by a few septal lamellae is observed in all well-preserved calices. The attachment area ranges considerably in size and shape.

NEOKONINCKOPHYLLUM KANSASENSE variant 1, Cocke

In transverse sections, major septal number ranges from 22 to 26. The septal ratio ranges between 2.1 and 3.2. Most major septa extend more than three-fourths of the corallite radius; a few extend into the central area where their axial ends join to form a weak columella. Generally, major septa are thin and crooked; however, lanceolate forms are common locally in several individuals. Minor septa are common in neanic and early ephebic stages, but generally are lacking or present in only a few septal loculi in brephic and late ephebic stages. Where present, they are thin and rarely exceed one-tenth of major septal length. The dissepimentarium commonly comprises approximately one-third of the corallite diameter. It is composed largely of complete or incomplete axially convex dissepiments which are moderately to tightly packed. Dissepiments in which both ends terminate against a single major septum are rare. A herringbone pattern consisting of incomplete axially convex plates is common only in larger members of variant 1. Lonsdaleoid dissepiments are lacking. An inner wall occurs in a few specimens. The outer tabulae are anastomosing, incomplete, and axially convex. Where no inner wall is present, they are indistinguishable from dissepiments. The central area is occupied by a few gently curved tabulae and the fused or unfused ends of major septa. In a few specimens, no major septa extend into the central one-fourth of the corallites. Internally widely flaring forms resemble others except that more majors extend into the corallite center where they are faintly to strongly whorled.

In longitudinal section, the dissepimentarium varies from four-tenths to one-half of the corallite diameter at diameters near 11 mm. At diameters of 5.5 mm, it comprises less than one-third of the corallite diameter. As many as 12 dissepiments are present in 5 mm along the epitheca. Dissepiments are inclined at angles near 45 degrees except the innermost row which attain angles of 70 to 85 degrees. In some specimens, an inner wall is formed by stereoplasmic deposits on the innermost dissepiments. Outer tabulae are inclined in the same direction but at lesser angles than dissepiments. Approximately four to seven are present in 5 mm vertically. Inner tabulae are gently inclined axially, generally at angles between 5 and 30 degrees. Where tabulae intersect septa, they may be bracket-shaped. Near the axis, 12 to 15 occur in 5 mm vertically. Widely flaring individuals have similar internal characters except that inclination of central tabulae may exceed 30 degrees.

NEOKONINCKOPHYLLUM KANSASENSE variant 2, Cocke

Major septal number in late ephebic stage ranges between 25 and 32. The septal ratio ranges between 1.1 and 2.3 mm. Dissepiments are extremely thin to naotic in the outer dissepimentarium. Major septa may double in thickness in the tabularium. Typically, few extend into the corallite center. The septal formula is C5A7K7A5. The dissepimentarium is typically one-third to one-half of the corallite diameter. It usually consists of extremely closely packed dissepiments which are strongly convex axially. As many as 20 are encountered in 5 mm along the septal edge. Many dissepiments terminate against other dissepiments.

Irregular deposits of stereoplasm may form an obscure local inner wall. Tabulae which occur between major septa are indistinguishable from dissepiments. Many inner tabulae as well as some dissepiments appear circular in transverse section. The central area, which is largely free of major septal ends, is filled with widely spaced, highly curved to circular tabulae.

In longitudinal section, the peripheral band of dissepiments includes small, strongly curved dissepiments which are inclined at 45 degree angles near the epitheca and increase to nearly 85 degrees at the inner edge of dissepiments. Along the epitheca, 10 to 13 occur in 5 mm vertically. Most dissepiments are thickened by stereoplasmic deposits and can be distinguished easily from tabulae. Along the inner margin of the dissepimentarium, tabulae are inclined peripherally; inner tabulae are wide. Most are domal; however, many are recurved to bracket-shaped. Eleven to 16 are intersected in a vertical distance of 5 mm.

Of hundreds of specimens of *Neokoninckophyllum kansasense* variant 2 collected, only two were suitable for ontogenetic studies. Others were poorly preserved or possessed intense curvature in early stages which prohibited serial sectioning. Individuals with complex attachment areas were rejected.

The lowest section available has a diameter of 1.9 mm and 9 major septa (Fig. 5). The septal formula is

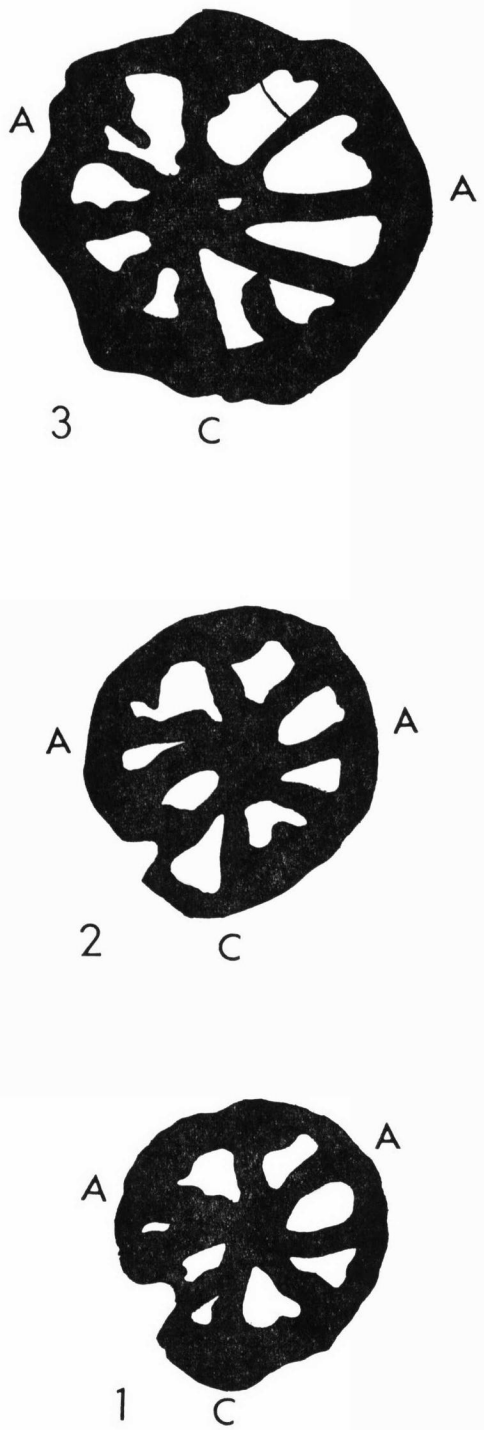


FIG. 5. Serial transverse sections of *Neokoninckophyllum kansasense* var. 2 from the Westerville Limestone at Loc. Wes2, all ×20.——*1*. Section showing eight thick major septa; septal formula C2AKA2.——*2*. Section with ten major septa including two newly inserted ones adjacent to the cardinal septum and one alar septum; septal formula C2A1K1A2.——*3*. Section similar to *2* but taken at a larger diameter. [*C*, cardinal septum; *A*, alar septum.]

C2A1KA2. All fully developed major septa join with the counter-cardinal crossbar. Subsequent sections show insertion of major septa on the counter side of the cardinal and alar septa. Septa may arise as stout protuberances from the epitheca or they lean against adjacent primary septum. The epitheca remains thick throughout the lower corallite stages comprising as much as one-fourth of the corallite radius. Tabulae enter at a diameter of 2.5 mm and are thin and widely spaced. The highest section studied possesses 11 septa; most are joined near the center.

The second specimen studied (Fig. 6) is almost complete. The following is a synopsis of the brephic ontogeny studied from 25 closely spaced transverse sections taken from the lower 4 mm of the corallite.

The lowest section studied (Fig. 6,*1*) has a diameter of 0.8 mm of which approximately one-half is comprised of a thick epitheca. The only recognizable septa form an irregular counter-cardinal crossbar. Tabulae are lacking.

At a diameter of 0.9 mm, two small protuberances located on opposite sides of the corallite and approximately midway between the ends of the crossbar represent the alar septa (Fig. 6,*2*).

In the next section (Fig. 6,*3*) at a diameter of 1.0 mm, one of the alar septa extends to join the crossbar. In addition, one counter-lateral septum unites with the crossbar near its counter end. The other alar septum continues as a low mound on the inner epitheca. Approximately 0.4 mm higher, the first metaseptum forms and extends to join the counter-cardinal structure. Also, the second counter lateral enters as a low protuberance; both this septum and the nearby alar remain low for approximately 1 mm vertically.

No septa are added until a diameter of 1.6 mm is reached (Fig. 6,*4*). However, all septa extend to the central crossbar, obscuring bilateral symmetry and forming a radial pattern. At the diameter indicated a septum is inserted on one side of the cardinal septum, resulting in a septal formula of C2A1K1A2.

Septal insertion is slow throughout most of the corallite studied. Tabulae are introduced at a diameter of 2.4 mm (Fig. 6,*5*). A tendency for the retreat of major septa from the corallite center is well established at a diameter of 3.0 mm. A few of these are free; others lean against adjacent septa. A trend toward septal thinning is noted here. At this diameter, a few dissepiments appear in the epitheca. Minor septa were not identified positively.

At a diameter of 4.0 mm (Fig. 6,*6*) 16 major septa are present, represented by the formula C2A5K3A2. Major septa are thin and sinuous. The majority of septa exceed three-fourths of the corallite diameter in length. No major septa join at the center, although a few extend into the region. A dissepimentarium is present along the periphery consisting of a single row of thick axially

convex dissepiments. A weak columella consists of axial ends of major septa and intercepted tabulae.

Discussion.—The species described as *Campophyllum kansasense* by Miller & Gurley (1893) is from an unknown horizon in the Kansas City metropolitan area. Comparison by me of type specimens with large collections from the Westerville Limestone, Cherryvale Formation, strongly indicates that the type specimens are from the Westerville. The lectotype (Walker Museum no. 47235) and 2 paralectotypes (Walker Museum no. 6616) are representative of the here-defined *Neokoninckophyllum kansasense* variant 2. Easton (1944) redescribed specimens collected by Miller & Gurley and tentatively assigned them to *Bothrophyllum* Trautschold (1879). However, examination of type specimens as well as others from the Westerville shows no cyathopsid septal thickening which is diagnostic of *Bothrophyllum*.

Morphological differences between the two variants of *Neokoninckophyllum kansasense* ordinarily would be sufficient to delineate separate species. However, the general geographic separation is distinctly related to distribution of lithic types in the Westerville Limestone. *N. kansasense* var. 1 is largely restricted to sparry algal calcilutite and calcareous shale of the Westerville algal-mound complex. At Loc. Wes1, these corals occur with abundant phylloid algae, lophophyllid corals, and fenestrate bryozoans, as well as the brachiopods *Composita* sp., *Marginifera* sp., *Neospirifer* sp., and *Antiquatonia* sp. Also present are intermediates between the two variants as well as a few individuals of *N. kansasense* var. 2 described here. A gradational series between the two coral variants closely corresponds to the gradation between the phylloid algal complex at Loc. Wes1 and the oolite bar at Loc. Wes2. Here thousands of specimens of *N. kansasense* var. 2 occur at the top of a large oolite bank with a few other invertebrates. The wide difference between the two variants is believed to be a reflection of the environmental difference between the algal-mound complex and the oolite bar.

Material Studied.—Over 100 specimens of *Neokoninckophyllum kansasense* var. 1 have been collected from Locs. Wes1, Wes2, and Wes3. Thirty-four trans-

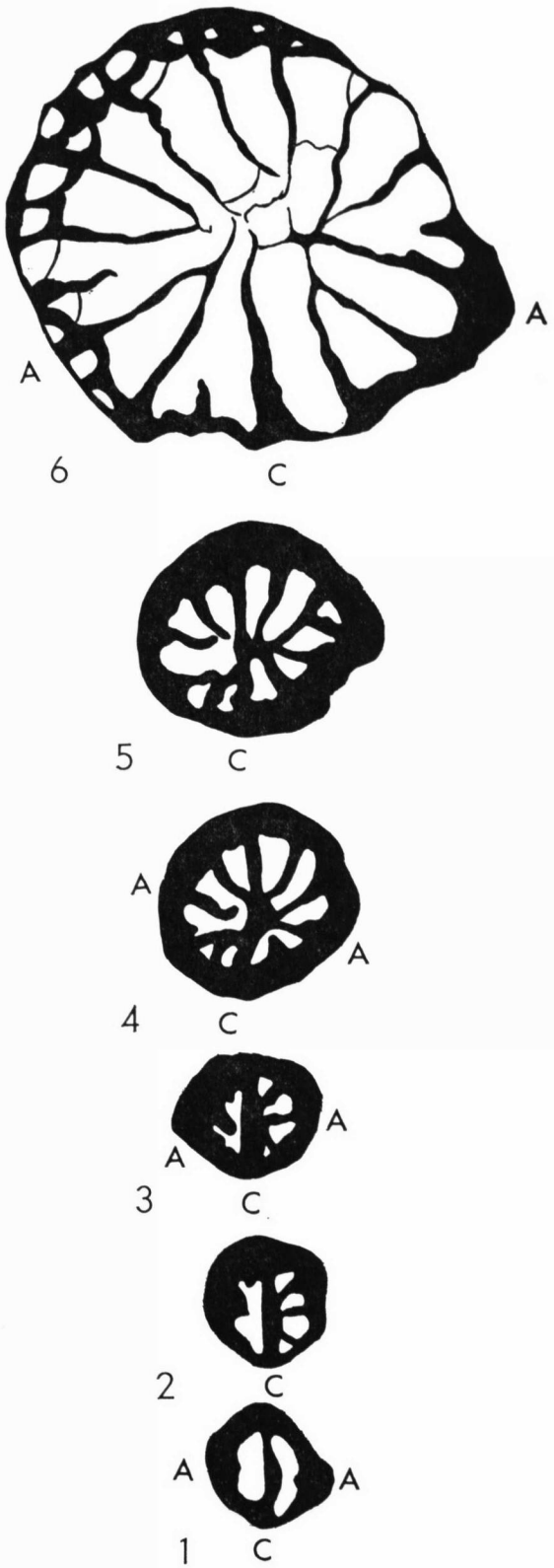


Fig. 6. Serial transverse sections of *Neokoninckophyllum kansasense* var. 2 from the Westerville Limestone at Loc. Wes2, all ×16.5.——*1*. Section showing counter-cardinal crossbar and small protuberances on each side which become alar septa in higher sections; septal formula C1K1.——*2*. Section of seven-septate stage showing counter-cardinal crossbar; 2 majors on one side and 3 on the other; septal formula C3K2, alar septa not identifiable.——*3*. Section similar to 2 except that at larger diameter septa are more highly developed; septal formula is C1A1K1A1.——*4*. Section with ten major septa characterized by a septal formula of C4K4 or C1A2K1A2; alar septa not positively identifiable.——*5*. Section with 11 major septa, septal formula, C1A3K4.——*6*. Section with 16 major septa and septal formula of C2A4K4A2. [*C*, cardinal septum; *A*, alar septum.]

verse and 11 longitudinal thin sections were prepared. Several hundred individuals of *N. kansasense* var. 2 have been collected largely from Wes2 but also from Wes1 and Wes3. Seventeen transverse and eight longitudinal thin sections were prepared. The holotype (Walker Museum no. 47235) and two paratypes (Walker Museum no. 6616) are now in the Field Museum of Natural History, Chicago, Illinois.

NEOKONINCKOPHYLLUM CYSTOSUM Cocke, n. sp.

Figures 7-8

Axophyllum? sp. D GIRTY, 1915, p. 315-316.

DIAGNOSIS.—Small conicocylindrical corals comprise the species. Major septa are thin and sinuous and extend two-thirds to three-fourths of the corallite diameter. Lonsdaleoid dissepiments commonly interrupt the major septa near the periphery. Minor septa are present in a few interseptal spaces. The normal and lonsdaleoid dissepimentaria commonly reach one-third of the corallite radius. The central area in transverse section may be empty or filled with widely spaced septal lamellae and intercepted tabulae; in longitudinal section, the central zone is filled with rounded, closely packed, gently inclined tabulae.

EXTERNAL CHARACTERS.—Two partial specimens were examined. The more complete one measured 35 mm in length and had a diameter of 12 mm. Both are solitary and conicocylindrical. The epitheca is poorly preserved, but fine transverse growth lines, larger growth wrinkles, and rejuvenescent stages are recognized.

TRANSVERSE SECTION.—Twenty-one major septa are present in all sections studied; the specimens have diameters near 12 mm. Major septa are thin and commonly terminate at points two-thirds to three-fourths of the corallite diameter. A few extend farther as thin lamellae into the central region of the corallite. They are thin and slightly sinuous. Minor septa have been observed in a few interseptal spaces in the lower transverse section of the paratype (Fig. 7).

In transverse section, the elements of the normal dissepimentarium cannot be differentiated from the tabulae, for elements of both are loosely packed. Most are incomplete, anastomosing and axially convex. Irregular plates are common. In the region near inner ends of major septa, tabulae are complete, barlike, axially convex or peripherally convex. No inner wall is apparent. An outer zone of highly convex, closely packed lonsdaleoid dissepiments comprises as much as one-third of the corallite diameter in the holotype. Other sections of the holotype and paratype show widely spaced peripheral cysts. No septal crests are present in the lonsdaleoid dissepimentarium. The central area of the corallite may be barren of all structural parts, as in the upper section of the holotype, or filled with irregular septal lamellae and widely spaced tabulae (Fig. 8).

LONGITUDINAL SECTION.—The dissepimentarium is equal in width to one-third of the corallite diameter and consists of variously sized dissepiments which are globose and inclined toward the periphery at angles near 45 degrees. The innermost dissepiments are less globose and almost vertical. Three to five dissepiments occur in a vertical distance of 5 mm. The tabularium consists of an outer zone of widely spaced anastomosing plates and an inner zone of more gently inclined tabulae which are closely packed and comprise approximately one-third of the corallite diameter. A few irregular septal lamellae are intersected. As many as eight tabulae are present in 2 mm vertically.

DISCUSSION.—This species is based on two specimens collected by G. H. GIRTY at locality 423 "in Kansas City, Mo. Kansas City Southern Ry., east of Zoo, in Swope Park. BROADHEAD'S limestone 74. Hertha limestone member of Kansas City formation" (GIRTY, 1915, p. 371). My efforts to find this locality have been unsuccessful. GIRTY described these specimens as *Axophyllum?* sp. D.

The presence of a prominent lonsdaleoid dissepimentarium in the holotype differentiates the species from members of *Neokoninckophyllum kansasense* and *N. petilum* COCKE, n. sp. Characters of the axial region separate it from *N. acolumnatum* COCKE, n. sp.

MATERIAL STUDIED.—See discussion above. The holotype and paratype are reposited in the Smithsonian Institute, Washington, D.C. with other corals of GIRTY'S collection of 1915.

NEOKONINCKOPHYLLUM TUSHANENSE (Chi, 1931)

Plate 4, figures 1a-b, 2a-b, 3a-c, 4, 5, 6a-b, 7a-b

Koninckophyllum tushanense CHI, 1931, p. 12-13, pl. 1, fig. 1a-d.
?Neokoninckophyllum dunbari ROSS & ROSS, 1962, p. 1171, pl. 160, figs. 3,5; text fig. 4-A, 5.
Axophyllum infundibulum GIRTY, 1915, p. 312 *(partim)*.

DIAGNOSIS.—Moderately large ceratoid to subcylindrical corallites comprise this species. Most major septa range from one-third to four-fifths of the corallite radius. Minor septa are absent or irregularly distributed in ephebic stages but are more abundant in early stages. The dissepimentarium is typically less than one-third of the diameter and is largely composed of incomplete, axially convex dissepiments. Lonsdaleoid dissepiments rarely occur. In transverse sections the central area is highly variable. Most commonly this region contains only tabulae but other members of the species show scattered septal lamellae or major septal extensions combined with tabulae. In longitudinal section an outer tabularium consists of distally convex plates which are inclined peripherally. The inner tabularium is composed of broad, closely packed, domal plates which may sag slightly in the corallite center.

EXTERNAL CHARACTERS.—The corallites here described

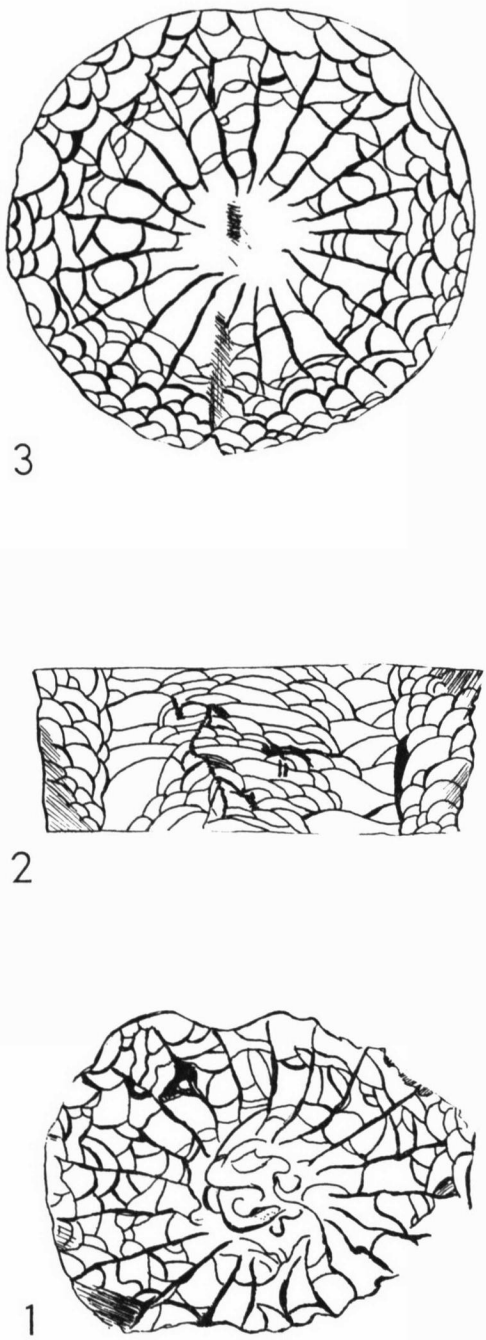


FIG. 7. Holotype of *Neokoninckophyllum cystosum* COCKE, n. sp., from Hertha Limestone, Kansas City, Missouri, ×5.5.——*1*. Transverse section, late ephebic stage showing prominent lonsdaleoid dissepimental zone and lack of columella.——*2*. Longitudinal section.——*3*. Transverse section of middle ephebic stage with impersistent lonsdaleoid zone and columella consisting of intersected tabulae and septal lamellae. [Cross-hatched area indicates poor preservation or breakage.]

are ceratoid to subcylindrical. Heights of 22 to 43 mm and diameters of 14 to 22 mm have been observed. The epitheca is thin and marked by two orders of transverse elements, wrinkles, and fine growth lines.

The calyx is deep and contains a low columella on which lamellar ridges are observable. Proximally, a flat irregular attachment area is rimmed by low ridges and spines.

TRANSVERSE SECTION.—Major septa number 29 to 33 at diameters exceeding 13 mm. In the ephebic stage of most corallites, major septa are approximately one-third to four-fifths of the corallite radius. Major septa are thin in the outer normal dissepimentarium but thicken slightly at the inner dissepiments and thin progressively to the terminal point. Major septa may degenerate peripherally or, in a few specimens, terminate against lonsdaleoid dissepiments. Typically, minor septa are absent or are irregularly distributed. They are extremely thin and less than one-tenth of major septal length. More are present in early stages where they may be one-fifth as long as major septa. The normal dissepimentarium at its maximum development comprises one-half of the corallite diameter and more commonly, slightly less than one-third of the corallite diameter. Dissepiments are closely packed. Axially convex, incomplete dissepiments are considerably more numerous than other types. Near the inner margin of the dissepimentarium both incomplete and complete peripherally convex dissepiments are dominant. An impersistent zone of irregular to angulate lonsdaleoid dissepiments occurs in ephebic stage of a few specimens. An inner wall is absent except in a few forms. Rarely, wide axially convex tabulae have short septal spines along the inner margin.

Considerable variation exists in the central area in the ephebic stage. In no instances are structures closely packed. Most commonly the axial area is free of all structures except a few long, widely spaced tabulae. In specimens possessing highly curved and extremely numerous tabulae, a loose meshwork of these structures simulates a columella. Other central structures are combinations of irregular septal lamellae, extensions of whorled major septal ends, and irregular tabulae.

LONGITUDINAL SECTION.—The peripheral zone of the dissepimentarium is moderately wide in ephebic stages and decreases progressively toward the apex. Six to eight rows are common in ephebic stages. Dissepiment size is variable; however, most are small and vesicular. Slope of the dissepiments is highly variable within an individual corallite. Innermost dissepiments are not noticeably thicker. The tabularium consists of outer and inner divisions. The former has widely separated axially convex plates inclined toward the periphery. These tabulae support outer ends of the inner tabulae. In most specimens, tabulae of the inner zone are broadly domal and closely packed. Common in several corallites are sweeping

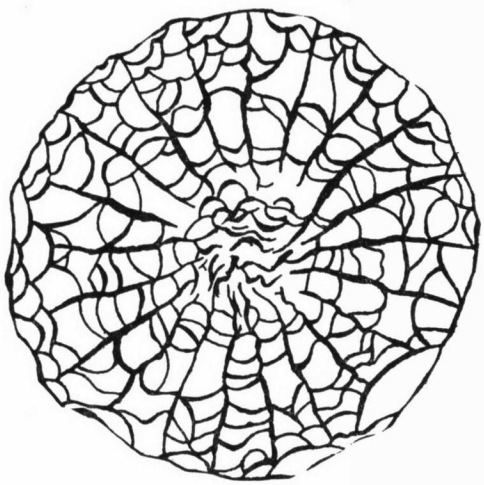


FIG. 8. Transverse section of paratype of *Neokoninckophyllum cystosum* COCKE, n. sp., from Hertha Limestone, Kansas City, Missouri, ephebic stage showing loose columella and lonsdaleoid dissepiments, ×6.

domal tabulae which sag slightly along the center. The tabulae incline against intersected lamellae at angles less than 30 degrees.

DISCUSSION.—In ephebic stages, *Neokoninckophyllum tushanense* differs from specimens of *N. acolumnatum* COCKE, n. sp., from the Winterset Limestone in possessing 1) fewer minor septa, 2) compact dissepimentarium and tabularium, 3) numerous incomplete axially convex dissepiments, 4) more major septa, and 5) variability of the central area. Although it is possible that the two species here described may represent ecological variants of a single species, the rather distinct morphology, as well as common occurrence together, offers rather strong evidence that differentiation of the two species is justified.

Characters of the holotype of *Neokoninckophyllum tushanense* from the Middle Carboniferous of China, are similar to those shown in specimens described here, except for larger size of the former. The latter shows more variability, particularly in the central zone where major septal ends and tilted tabulae may form a loose columella. *N. dunbari* Ross & Ross (1962) based on a single specimen from the Gaptank Formation, Desmoinesian of the Glass Mountains of Texas, differs from the holotype of *N. tushanense* in having several major septa united at the corallite center. However, the Texas specimens fall into the range of variability shown by Kansas Missourian specimens.

Variation range with *Neokoninckophyllum tushanense* is similar to that between individuals of the Morrowan Wapanucka species, *Koninckophyllum simplex* (MOORE & JEFFORDS, 1945) and *K. oklahomense* ROWETT & SUTHERLAND (1964) which were collected from similar stratigraphic intervals but different localities. The species described herein can be differentiated from *K. simplex* on the basis of downsagging tabulae, cardinal fossulae, and more numerous major septa in the latter. Persistent inner wall, wider dissepimentarium, and persistent columella of *K. oklahomense* separate it from *N. tushanense*. *K. nitellum* (MOORE & JEFFORDS, 1945) has persistent minor septa which are two-thirds of major septal length, in contrast to the diminutive minor septa of *N. tushanense*.

Lower Carboniferous Spanish koninckophyllids *Koninckophyllum histiophylloides* DEGROOT (1963), *K. multilamellatum* DEGROOT (1963), as well as the Westphalian *K. gentisae* DEGROOT (1963), differ in possessing a rather distinct columella, long minor septa, an inner wall, and major septa considerably thickened in the tabularium.

MATERIAL STUDIED.—Approximately 150 specimens were collected from Locs. H7, H9, BF1, BF4, BF5, BF6, BF7, BF8, Win1, Win3, and Win8. In addition, one specimen belonging to the species was collected by GIRTY (1915) from the Hertha Formation in Kansas City, Missouri, and described as *Axophyllum infundibulum* MEEK & WORTHEN (1875). Figured specimens are SUI 33878, SUI 33877 and SUI 33876.

NEOKONINCKOPHYLLUM PERPLEXUM Cocke, n. sp.

Plate 4, figures 8, 9, 10a-b, 11a-b

DIAGNOSIS.—Corals of moderate size with transverse wrinkles and growth lines comprise this species. The epitheca is thin in the upper part of the corallite but thickens apically where dissepiments are lacking. The dissepimentarium is narrow, commonly with two or three rows of both complete and incomplete dissepiments. Stereoplasmic deposits on the innermost row form a prominent inner wall. Major septa are equal in length to three-fourths of the corallite radius. They are thin in the dissepimentarium but approximately double in thickness at the outer margin of the tabularium. Minor septa are absent in most specimens; where present they are spinelike and measure less than one-tenth of major septal length. The columella is variable, consisting of 1) an isolated bar and thickened tabulae, 2) elongation or thickening of a major (counter?) septum joined by a few thick radiating lamellae, and 3) irregular and randomly oriented lamellae. Numerous tentlike tabulae are moderately to steeply inclined against the central plate of the columella; in specimens with weak columella, the tabulae are domal with septal parts distributed along the crests.

EXTERNAL CHARACTERS.—Because most specimens are imbedded in a limestone matrix, external properties are little known. Specimens are apparently solitary, gently flaring to cylindrical. The epitheca is smooth and not marked by longitudinal ridges and grooves. Maximum length and diameter of fragmental material are 14 and 15.5 mm respectively.

Transverse Section.—Major septa are equal to approximately one-half to three-fourths of corallite radius, thin and crooked in the dissepimentarium and thick and less crooked in the tabularium. The septal formula is unknown. Maximum septal number is 29 in one incomplete corallite. Twenty-six majors are present at maximum complete diameter of 15.5 mm. No fossula is present. Minor septa are commonly lacking in the dissepimentarium; where present they are spinelike and less than one-eighth of major septal length. The dissepimentarium is narrow, consisting of one to four rows of dissepiments. Most dissepiments are incomplete and axially convex. The innermost dissepiments, thickened by stereoplasmic deposits to form a prominent inner wall, are complete and convex peripherally.

The columella is variable, generally consisting of an elongate median plate isolated or connected to a major septum with thickened tabulae and radiating lamellae. Rarely, the central area has randomly oriented lamellae and widely separated tabulae.

Earlier sections show gradual disappearance of dissepimental rows, and a fusion of the inner wall with the epitheca. At a diameter of 8 mm, 24 major septa, scattered dissepiments, and columella are present. In paratype, SUI 33891, at a diameter of 4.5 mm, 11 major septa are present. The epitheca is thick and no dissepiments are seen. Major septa are irregular in length and shape. No columella or cardinal-counter crossbar is present.

Longitudinal Section.—Steep dissepiments of uniform size comprise a narrow peripheral zone; the innermost dissepiments are thickened by stereoplasmic deposits to form a distinct inner wall. The outer tabularium has incomplete tabulae which are tilted peripherally and convex upward. Forms with a distinct median plate have as many as 14 moderately to steeply inclined tabulae in 5 mm along the plate. Forms with obscure or no median plate have approximately 9 domal to platform tabulae in 5 mm vertically. Parts of the lamellae are distributed unevenly along the upper surfaces.

Discussion.—The species differs from all known described species of *Neokoninckophyllum* in possessing a highly variable solid columella and thick major septa. It differs from *N.* sp. A in possessing a more narrow normal dissepimentarium and thicker and more regularly developed major septa. In addition, *N.* sp. A has a distinct lonsdaleoid dissepimental zone. Although the two species are distinct morphologically, the possibility exists that they are part of a single highly variable species.

Material Studied.—Ten fragmental specimens were collected from the undifferentiated Hertha Formation at Locs. H1, H3, and H7. Twelve transverse and six longitudinal sections were made. Holotype is SUI 33890 and paratypes are SUI 33891 and SUI 33889.

NEOKONINCKOPHYLLUM ACOLUMNATUM Cocke, n. sp.

Plate 4, figures 13a-c, 14a-b; Plate 5, figures 1a-b, 2a-b

Diagnosis.—Slender solitary corals with smooth transverse wrinkles and growth lines comprise this species. Major septa number 18 to 29 and are short, rarely attaining more than three-fifths corallite radius. Septa are thin, threadlike and crooked throughout their length. Minors where present are straight and less than one-fifth of major septal length. Dissepiments form a narrow peripheral zone equal in width to one-fifth of corallite diameter. An inner wall is present in the ephebic stage of some specimens. Tabulae are broadly domal to barlike; many are complete.

External Characters.—Corallites are solitary and slender; a few Plattsburg forms are flattened, with major axes approximately twice the minor axis length. Maximum observed diameter and length are 17 and 26 mm respectively. Smooth wrinkles and thin closely spaced growth lines traverse the epitheca. Attachment surfaces are irregular and small. The calyx is moderately deep, with a low tabular mound in the axial area.

Transverse Section.—Most major septa, numbering 18 to 29, are thin and crooked throughout their length but may be slightly thickened and straighter in the tabularium. None of the individuals collected from the Plattsburg Formation show septal thickening in the tabularium. Major septa rarely exceed three-fifths of the corallite radius and many are less than one-third of the radius. In some specimens, isolated septal spines occur on tabulae. No fossula is identified. In several specimens, major septa are deflected in a common direction near their mid-point. Minor septa are thin and straight; in most specimens they occur in less than one-half of the interseptal loculi and are less than one-fifth of major septal length. The narrow dissepimentarium consists of two to four rows of axially convex to irregular incomplete dissepiments. A partial lonsdaleoid dissepimentarium consisting of irregular dissepiments is seen in several specimens. An inner wall is present in some forms. A few specimens have irregular septal lamellae in the central area.

Longitudinal Section.—The dissepimentarium is narrow, consisting of two to four rows of steeply inclined dissepiments. Seven to 14 dissepiments occur in 5 mm vertically. The tabularium is wide, with auxiliary tabulae in the outer tabularium. In forms which have no septal lamellae, many tabulae are complete but vary in shape from domal, horizontal to sagging, and are widely separated. Forms possessing septal lamellae have tabulae inclined at low angles against the lamellae. However, small globular dissepiments are closely grouped on larger tabulae.

Discussion.—The species has been collected from the Hertha, Swope, Winterset and Plattsburg Formations. Forms from the Hertha are moderately large, have no inner wall, minor septa, or central septal lamellae. Those from the Swope and Winterset possess minor septa and

a few have an inner wall; a partial columella is formed by irregular septal lamellae in a few specimens. Plattsburg forms differ slightly from other members of the species in flattening of some specimens and generally larger size. The species may be artificial. In all instances, it occurs with large neokoninckophyllids which possess widely spaced dissepiments. This species differs from all other neokoninckophyllids in the simplicity of its skeletal elements.

Material Studied.—Fourteen specimens were collected from Locs. H1, BF4, BF6, Win1, Win3, Win8, and Pb8. Eleven transverse and seven longitudinal sections were prepared. The holotype is SUI 33887; paratypes are SUI 33886 and SUI 33885.

NEOKONINCKOPHYLLUM VARIABILE Cocke, n. sp.

Plate 5, figures 3, 4a-d, 5, 6, 7a-c, 8a-b, 9, 10a-b, 11

Diagnosis.—Corals of this species are solitary, gently flaring in early stages and conicocylindrical in late stages. Rejuvenescence is rare. The center of the calyx is occupied by a low boss. Major septa are thinly lanceolate and cross two-thirds to three-fourths of the corallite radius. Minor septa generally are missing in the ephebic stage and diminutive or missing in earlier stages. The dissepimentarium is one-third to one-half the width of the corallite diameter, and consists largely of axially convex dissepiments which are complete or incomplete. Spacing of dissepiments varies considerably. Lonsdaleoid dissepiments are present in many specimens but do not form a prominent zone. An inner wall is generally not developed but in some specimens is pronounced.

The columella is quite variable, consisting of 1) a simple, slightly rhopaloid extension of the counter septum, 2) extension of the counter septum with a few irregular radiating lamellae, 3) a diffuse pattern of septal lamellae and intersected septal ends, 4) irregularly distributed carinate lamellae and intersected tabulae, and 5) radiating lamellae which join at the center of the corallite; no median lamella is present. In longitudinal section, the central tabulae are gently inclined and variously spaced.

External Characters.—Specimens are solitary and gently flaring conicocylindrical, with moderately deep calices and low central bosses. Lengths of fragmental specimens range between 20 and 60 mm; diameters at the top of the calices range from 9 to 17 mm. The epitheca is smooth and crossed by fine, closely spaced growth lines and rare major transverse ridges. Triangular to irregular attachment areas occur on well-preserved specimens.

Transverse Section.—Major septa range in number from 23 to 30, with average near 26. The length of major septa is equal to two-thirds to four-fifths of the corallite radius. They are thinly lanceolate and moderately crooked. A single septal formula is C6A7K7A6. Minor septa are missing in late ephebic sections. In earlier stages, they are diminutive, rarely exceeding one-fifth of major septal length. The dissepimentarium, where it can be distinguished from the tabularium, is one-third to one-half of the corallite diameter. It consists largely of complete and incomplete axially convex dissepiments to irregularly curved dissepiments. An inner wall is locally present in some individuals.

In late ephebic stages tabulae anastomose generally as axially convex plates which are indistinguishable from dissepiments. Earlier stages exhibit a more definite separation; the tabulae are more widely spaced and barlike to gently curved toward the periphery.

Four intergrading collumellar forms are observed: 1) a simple slightly rhopaloid extension of the counter septum, 2) extension of the counter with a few irregular radiating lamellae, 3) a diffuse pattern of septal lamellae and intersected septal ends, and 4) irregularly distributed carinate lamellae and intersected tabulae. Earlier sections may be similar to those just described, but the radial pattern may be replaced by spiral lamellae. Tabular elements are irregular and widely spaced throughout the columella.

Longitudinal Section.—The dissepimentarial zone is one-third to one-half of the corallite diameter and consists of closely packed dissepiments inclined consistently near 45 degrees. Dissepiments are variable in size and locally are thickened by stereoplasmic deposits. Twelve to 15 commonly occur in 5 mm vertically. The demarcation between the dissepimentarium and tabularium may be gradational or sharp; dissepiments are locally thickened differentially in some specimens at the juncture of the dissepiments and tabulae. The tabularium consists of two anastomosing zones: 1) an outer zone of peripherally inclined plates which are widely separated, and 2) an inner series of axially inclined tabulae which are generally steeper than the outer zone, although innermost tabulae may be nearly vertical. The columella width is approximately one-third of the corallite diameter. Tabulae are variously packed; as many as 25 occur in 5 mm vertically. They are nearly horizontal and bracket-shaped. Short rugged radiating lamellae are haphazardly distributed throughout the columella.

Discussion.—This species is one of the most variable of all known Missourian neokoninckophyllids. Forms found in the Wyandotte Limestone typically possess a simple columella consisting of a thin faintly rhopaloid extension of the counter septum which may be augmented by a few septal lamellae and tabular ends. This group of *Neokoninckophyllum variabile* is particularly abundant in the normal facies of the next higher limestone, the Plattsburg Formation. However, occurring in the normal facies and in the northern algal-mound complex are all other columellar variations listed in the species description.

In the southern Plattsburg algal-mound complex, a common member of the species contrasts sharply with most representatives in possessing widely spaced dissepiments and a dibunophylloid columella. The intergradational nature of these corals to other members of the *Neokoninckophyllum variabile* assemblage prohibits species separation.

Neokoninckophyllum variabile most closely resembles *N. heckeli* Cocke, n. sp., from the Stanton Formation; see Discussion section of the latter.

Clisiophyllum carnicum Heritsch (1936a) (=*Amandophyllum carnicum* Heritsch, 1941), from the Upper Carboniferous of the Carnic Alps, closely resembles specimens of *N. variabile* from the southern algal complex of the Plattsburg. Particular points of similarity are 1) narrow dissepimentarium, 2) long thick major septa, and 3) dibunophylloid columella with axially convex tabulae. Separation of the two species is based on the presence of strongly developed minor septa in *C. carnicum*.

Dibunophyllum exiguum Jeffords (1948a) is separated from this species largely on the basis of having steeper tabellae along the median lamella as shown in longitudinal sections. Transverse sections of *Dibunophyllum* sp. from Namurian rocks of Spain (DeGroot, 1963) differ only in possessing a wider dissepimentarium.

Material Studied.—More than 300 specimens were collected from Locs. Wy1, Wy2, Wy3, Wy7, Wy8, Wy9, Wy10, Wy11, Wy12, Pb1, Pb2, Pb3, Pb4, Pb5, Pb6, Pb7, Pb8, Pb9, Pb10, Pb11, and Pb13. More than 200 thin sections were prepared. The holotype is SUI 33869; paratypes are SUI 33868, SUI 33867, SUI 33866, SUI 33865, SUI 33864, and SUI 33863.

NEOKONINCKOPHYLLUM HECKELI Cocke, n. sp.

Plate 6, figures 8a-b, 9a-b

Diagnosis.—The species consists of elongate gregarious and perhaps fasciculate individuals with a smooth epitheca crossed only by closely spaced growth annulations. The moderately deep calyx possesses a low central boss. Major septa are sublanceolate to lanceolate. The narrow dissepimentarium consists of axially convex, steeply inclined dissepiments on which stereoplasmic spines and nodes are common. The columella comprises one-third of the corallite diameter and may consist of irregular tabular ends, randomly arranged septal lamellae, rhopaloid extensions of the counter septum, and a median lamella with scattered radiating lamellae.

External Characters.—Most specimens are solitary but highly gregarious; commonly numerous individuals are found *in situ* on large basket-shaped calcisponges. Mature specimens are subcylindrical. Many attain heights and diameters of 23 to 47 and 11 to 14 mm respectively. Fine transverse growth lines are numerous; no individual is noticeably rejuvenescent. Calices are moderately deep, with a low round median boss which may extend 2 to 4 mm above the calyx floor.

Transverse Section.—The epitheca is relatively thick, varying from 0.3 to 0.4 mm. One order of septa is typically present. At diameters between 11 and 14 mm, 21 to 25 major septa are present crossing approximately three-fourths of the corallite diameter. Few enter the central area. They are sublanceolate to lanceolate with maximum thickness occurring near the inner wall. The septal formula is C4A5K5A4. Minor septa are rare in most sections; however, all transverse sections examined have minor septa in some septal loculi. They vary from stubby ridges to thin spines which rarely reach one-tenth of major septal length. Minor septa are particularly well developed in forms with pronounced columellae. Both minor and major septa commonly rest on low epithecal ridges. One-fifth to one-fourth of the corallite diameter is occupied by the dissepimentarium. Typically dissepiments are axially convex, incomplete, and densely packed. In several ephebic sections, many dissepiments, particularly those near the inner wall, possess small knobs and spines of stereoplasm on the axial side. The boundary between the dissepimentarium and tabularium is a prominent inner wall formed by stereoplasmic deposits on innermost dissepiments. Small rounded to angulate lonsdaleoid dissepiments are present in a few specimens.

Tabulae are widely spaced and vary considerably in convexity in the outer tabularium. Peripherally convex tabulae are proportionately more numerous as the center is approached. The central area exhibits a variety of forms. One, which is most common, consists of tabular ends and septal lamellae in an irregular pattern resulting in a loose meshwork; another shows a slightly rhopaloid extension of the counter septum surrounded by peripherally convex tabulae; and a third has faintly dibunophylloid structure consisting of a median plate with a few irregular radiating lamellae and tabulae.

Longitudinal Section.—Six to eight rows of dissepiments comprise the peripheral zone. Most are inclined at angles exceeding 60 degrees; at the inner margin many are vertical. Small stereoplasmic nodes are distributed irregularly on many dissepiments. Locally, an inner wall is prominently developed. The outer tabularium consists of short, upwardly convex tabulae inclined at low angles in the same direction as the dissepiments but at lesser angles. These tabulae alternate with low-angle plates of the inner tabularium. The columella occupies one-third of the corallite diameter and consists of two interlocking structures. One, the tabulae range in shape from upwardly convex to sagging, although many are irregularly recurved. Spines similar to those on the dissepiments are common. Two, highly irregular curved septal lamellae are spaced randomly with tabulae. Few are longer than 2 mm.

Discussion.—This species is similar to *Neokoninckophyllum variabile* Cocke, n. sp., from the Wyandotte and Plattsburg Formations and may be derived from it.

The Stanton species differs in possessing 1) a narrower dissepimentarium, 2) a less variable columella, and 3) small carina-like protuberances on septa, tabulae, and dissepiments. Characters which separate *N. variabile* from *Clisiophyllum carnicum* HERITSCH (1936a) and *Dibunophyllum exiguum* JEFFORDS (1948a) also separate these species from *N. heckeli.*

MATERIAL STUDIED.—Approximately 100 specimens were collected from Locs. Pb11, St1, St2, St3, St5, St8, St10, St11, St14, St16, St20, and St23. Twenty-eight transverse and seven longitudinal sections were prepared. The holotype is SUI 33872 and the two paratypes are SUI 33871 and SUI 33870.

NEOKONINCKOPHYLLUM sp. A

Plate 4, figures 12a-b

EXTERNAL CHARACTERS.—A single fragment 15 mm long was studied. Epithecal, calicular and apical areas were destroyed by weathering.

TRANSVERSE SECTION.—Major septa numbering 28 in the highest section are moderately thick in dissepimentarium and tabularium but thin at their terminus 2 mm from the columella. No minors were observed. Four to six rows of complete and incomplete dissepiments, generally convex inward to irregularly curved, comprise the dissepimentarium. A moderately well-developed inner wall is formed on the innermost dissepiments. A band of lonsdaleoid dissepiments comprises the outermost zone. The columella in the highest section is a thin isolated bar; however, in the lowest section, it is the unthickened extension of a major (counter?) septum.

LONGITUDINAL SECTION.—The wide dissepimentarium is composed of an outer zone of large elongate lonsdaleoid dissepiments and an inner zone of smaller, more densely packed, more rounded dissepiments. An inner wall is formed by the inner row at the outer margin of the tabularium. Several convex tabulae are inclined toward the periphery. The inner tabulae are wide, tentlike, and inclined at moderate angles against the median lamella.

DISCUSSION.—Differences between this specimen and members of *Neokoninckophyllum perplexum* have been discussed above. The specimen superficially resembles a geyerophyllid in characters of the columella and lonsdaleoid dissepimentarium as shown in transverse section. In longitudinal section, however, the axially inclined tabulae indicate koninckophyllid affinities.

MATERIAL STUDIED.—One fragment, SUI 33888 was collected from Loc. H1. Two transverse and one longitudinal thin section were prepared.

Family CYATHOPSIDAE Dybowski, 1873

DIAGNOSIS

Generally solitary Rugosa which possess an open tabular fossula. Septa are typically dilated and amplexoid in the wide tabularium. The tabularium consists of complete, domed or flat tabulae with downturned edges. The dissepimentarium has regular or lonsdaleoid dissepiments. The cardinal septum is short; the counter septum is commonly elongate.

REMARKS

Corals assigned to Cyathopsidae were placed in Family Caniniidae by HILL (1938). These corals can be separated from aulophyllids by general lack of columella and by domed or flat tabulae. However, advanced stages of *Neokoninckophyllum* closely resemble those of some cyathopsid genera in these characters.

Genus CANINIA Michelin, 1840

[*Caninia* MICHELIN, 1840, p. 485]

TYPE SPECIES.—*Caninia cornucopiae* MICHELIN in GERVAIS, 1840.

DIAGNOSIS.—Simple rugose corals, in the early stages of which major septa are slightly sinuous and show lanceolate dilation in the tabularium, particularly in cardinal quadrants; the septa are long, particularly the counter septum, though an axial structure is not formed, or at least not in the type; they become amplexoid and less dilated in ephebic stages. The fossula is open, with a very short cardinal septum and neighboring septa curved gently about it. A dissepimentarium with concentric, inosculating or lonsdaleoid dissepiments may be developed. The tabulae are complete and flat, with downturned margins. (After HILL, 1938, p. 105.)

DISCUSSION.—In view of the gradational nature of accepted caniniid genera, I have adopted the rather broad interpretation of these corals advocated by HILL (1938, 1956). Early North American workers included most Upper Carboniferous caniniids in *Campophyllum* MILNE-EDWARDS & HAIME (1850), generally in *Campophyllum torquium* (OWEN, 1852). The species was reassigned to *Caninia* by EASTON (1944). Later workers (MOORE & JEFFORDS, 1945; SUTHERLAND, 1958; and FAGERSTROM & EISELE, 1966) have included larger caniniids with wider, more complex dissepimentaria in *Pseudozaphrentoides* STUCKENBURG (1904). Caniniids described in this report resemble *Pseudozaphrentoides* in possessing such a wide dissepimentarium. For more extended and excellent discussions of the problem, see HILL (1938, p. 102-106), MOORE & JEFFORDS (1945, p. 143-147), and SUTHERLAND (1958, p. 62-64).

CANINIA LINNENSIS Cocke, n. sp.

Plate 6, figures 1a-c, 2

DIAGNOSIS.—Medium-sized corals which, in addition to typical caniniid characters, have no minor septa in ephebic stages but possess distinctive lonsdaleoid dissepiments comprise this species. Major septa are thin in the dissepimentarium but thicken in the tabularium. In

length, they are equal to two-thirds of the corallite radius. A distinct fossula is characterized by a cardinal septum approximately one-half as long as other major septa. Minor septa occur in a few interseptal spaces. The dissepimentarium is approximately one-fifth as wide as the corallite. A prominent inner wall marks the intersection between the dissepimentarium and tabularium. Tabulae are domal and closely spaced in the central zone.

Transverse Section.—Twenty-eight to 31 major septa are thin to impersistent in the dissepimentarium but thick at the outer margin of the tabularium. They thin progressively and terminate at a length equal to two-thirds of the corallite radius. The cardinal septum lies in a distinct fossula and is approximately one-half as long as other major septa. Minor septa are absent in most specimens but are seen in a few specimens as thin spinelike protrusions, particularly in the early ephebic stage. The dissepimentarium composed of four to six rows of dissepiments is equal to one-fifth of the corallite radius and consists largely of wide axially convex to angulate incomplete plates. Elongate lonsdaleoid dissepiments comprise an impersistent outer zone in late ephebic stages. The boundary between the dissepimentarium and tabularium is a prominent inner wall formed by stereoplasmic thickening of inner dissepiments. The tabularium is wide, with unevenly distributed barlike to axially convex tabulae.

Longitudinal Section.—The dissepimentarium, bounded peripherally by a thin epitheca and axially by a prominent inner wall, consists of steep globular to elongate dissepiments. The tabularium is divided into two intergrading series. An outer one consists of supportive tabulae inclined in the same direction as the dissepiments but at lesser angles. The inner tabularium is composed of wide incomplete and complete domal tabulae which sag slightly in the central part. The inner tabulae are closely packed near the corallite center.

Discussion.—Transverse sections of *Caninia linnensis* Cocke, n. sp., differ from those of *Caninia torquia* (Owen) as redefined by Easton (1944) in showing impersistent minor septa, presence of lonsdaleoid dissepiments in late ephebic stages, and fewer major septa. Representatives of *C. torquia* from the Cement City Limestone are similarly differentiated from *C. linnensis*. This species resembles no other North American caniniid known to me.

Material Studied.—Twelve specimens were collected from the Hertha Formation at Locs. H1, H3, and H7. From these, nine transverse and three longitudinal thin sections were prepared. Types are holotype SUI 33881, and paratypes SUI 33880 and SUI 33879.

CANINIA TORQUIA (Owen, 1852)

Plate 6, figures 3a-b, 4a-b, 5a-b, 6, 7a-b

For synonymy see Easton (1944).

Diagnosis.—Individuals of this species are solitary and conical; the epitheca is marked by finely spaced growth annulations and major growth constrictions. Major septa extend well into the tabularium. They tend to be thick in the tabularium, particularly in cardinal quadrants and thin in the dissepimentarium. The cardinal septum lies in a prominent fossula. The dissepimentarium is approximately one-fourth as wide as the corallite diameter and has approximately 10 dissepiments in 5 mm vertically. Tabulae are platform to sagging and compose a zone approximately equal to three-fourths of the corallite diameter.

External Characters.—The species is composed of large individuals ranging in height from 40 to 120 mm and in diameter from 21 to 33 mm. Most become subcylindrical a short distance from the apex. The epitheca is crossed by fine growth lines and larger wrinkles. Calices are deep and cylindrical, with bilateral symmetry created by a deep prominent cardinal fossula. Hystero-corallites are distributed irregularly along large transverse ridges in higher areas of individuals. The differences between Cement City and Stoner forms are summarized in Table 6.

Transverse Section.—In diameters between 12 and 18 mm the major septal number ranges from 27 to 37. Major septa are typically two-thirds to three-fourths of the corallite radius. In highest sections of Stoner forms major septa are only slightly thickened in cardinal quadrants; a shortened cardinal septum lies in a moderately well-developed fossula and alar septa are not definitely recognizable. Lower ephebic sections show a greatly thickened cardinal septum approximately equal to two-thirds major septal length, and thickened major septa in cardinal quadrants which are thin in the dissepimentarium and lanceolate in the tabularium. Major septa in counter quadrants are thinner. In most specimens the thinning occurs abruptly on the counter side of alar septa; in others the thickness progressively decreases toward the counter septum. Only a single specimen from the Cement City Limestone shows distinctive cyathopsid thickening. The septal formula varies from C6A5K5A6 to C7A9K9A7 in ephebic stages. Minor septa are thin and spinelike, attaining lengths varying from one-fourth to one-sixth of major septal length. They may exist as septal crests in late stages of growth. Dissepiments occur in a peripheral band which ranges in width from one-fifth to one-sixth of the corallite diameter. In the area where minor septa extend, dissepiments are peripherally convex and complete; inwardly most are axially convex, incomplete, and form a herringbone pattern. In cardinal quadrants, a prominent inner wall is present. Tabulae exist as gently curved to straight interseptal plates.

Longitudinal Section.—As many as 10 steeply inclined dissepiments occur in 5 mm along the epitheca. Dissepiments increase slightly in size in an axial direction. Along the inner boundary three or four globose

TABLE 6. *Summary of Morphological Characters in Ephebic Stages of Type Specimens of* Caninia torquia *(Owen) and Representatives of the Species from the Cement City and Stoner Limestones.*

[MjT=major septal thickness; MjL=major septal length; card=cardinal septum; quad=quadrant; MnL=minor septal length; dissep=dissepiments or dissepimentarium; D=diameter; cx=convex; irreg=irregular; herrb=herringbone; ptfm=platform; tab=tabulae.]

TRANVERSE SECTION	TYPE SPECIMENS	CEMENT CITY	STONER
Septal number	45	30-34	27-37
Septal formula	Probably C11A10K10A10	unknown	C6A5K5A6 to C7A9K9A7
MjL	2/3 D	1/2-3/4 D	2/3-3/4 D
MjT in dissep	thin and crooked	thin and crooked	thin and crooked
MjT in tab	thick and straight	thick and straight	thick and straight
Card L	3/4 MjL	3/4 MjL	1/2-3/4 MjL
MjT in card quad	thicker	uniform	much thicker
MnL	1/5 to 1/8 MjL	1/4 MjL	1/6 MjL
Dissep width	1/3-1/2 D	1/4-1/3 D	1/6-1/5 D
Dissep pattern	complete and cx at periphery, herrb in	same	same
Inner wall	prominent in card quad	present	prominent in card quad
LONGITUDINAL SECTION			
Outer dissep spacing	10 in 5 mm.	10 in 5 mm.	9 in 5 mm.
Outer dissep shape	globose	globose	globose
Inner wall	present	present	present
Outer tab spacing	5 in 5 mm.	7 in 5 mm.	13 in 10 mm.
Outer tab shape	up cx	sagging to cx	cx to irreg
Inner tab	ptfm to sagging	ptfm to sagging	ptfm to sagging
Inner tab spacing	10 in 5 mm.	10 to 15 in 5 mm.	12 in 5 mm.

dissepiments occur in 5 mm vertically. The tabularium consists of two parts. The outer tabularium is comprised of upwardly convex to irregular incomplete tabulae in which the intersection point with inner tabulae is usually above the upper limit of the inner tabulae. Approximately seven occur in 5 mm. Peripheral ends of inner tabulae may cross the outer tabularium. The inner tabularium consists of platform tabulae which are generally incomplete. Nine to 12 occur in 10 mm vertically along the axis. Commonly the central part of the tabulae is sagging.

DISCUSSION.—Detailed collecting of Missourian formations has revealed caniniid corals in three limestone formations (Hertha, Drum, Stanton), in contrast with the reported occurrence of these forms in ten formations by JEFFORDS (1948b, p. 45). Three formations (Bourbon, Fontana, Vilas) are thick shales throughout most of their outcrop, from which I have been unable to collect any dissepimental corals. Large neokoninckophyllids which in late ephebic stage superficially resemble caniniids are common in the Swope, Dennis, Cherryvale, and Plattsburg Formations in limestone formations and may have been confused with caniniids by JEFFORDS.

Generic and specific designations among caniniids are particularly difficult because of lack of obvious pattern in the wide range of caniniid variation. Emphasis on the presence of cyathopsid characters in Stoner forms may well lead to differentiation of species between these and corallites from the Cement City Limestone. However, when viewed in the perspective of the extreme variation of caniniids from Lower Carboniferous to Upper Carboniferous such separation of species probably would be recognized as artificial.

MATERIAL STUDIED.—Approximately 40 individuals of the species were collected from the Cement City Limestone at Locs. Dr1 and Dr2, from which 14 transverse and six longitudinal sections were prepared. Specimens collected from the Stoner numbering well over 200 are from Locs. St1, St3, St17, St20, St27, and St29. Type specimens are U.S. National Museum no. 17953 and a lot collection U.S. National Museum no. 6839.

Family GEYEROPHYLLIDAE Minato, 1955 (Emended Cocke & Cocke, 1968)

[Geyerophyllidae MINATO, 1955, p. 155-157; COCKE & COCKE, 1968, p. 41-46]

DIAGNOSIS

Geyerophyllid corals are solitary to loosely fasciculate, longitudinally ribbed with shape ranging from widely flaring to conicocylindrical. Lonsdaleoid dissepiments commonly form a peripheral zone. The collumella invariably originates by extension and axial complication of the cardinal septum. It is highly variable. Other major septa rarely join the columella. Typically,

the tabularium consists of an inner zone of periaxially sagging to peripherally convex tabulae and an outer zone of more widely spaced axially convex plates. The epitheca is extremely thick in neanic and brephic stages.

REMARKS

As originally defined, Geyerophyllidae MINATO (1955) consisted of *Akiyosiphyllum* YABE & SUGIYAMA (1942), *Cionodendron* BENSON & SMITH (1923), and four genera *(Geyerophyllum, Lonsdaleoides, Carinthiaphyllum Carniaphyllum)* described by HERITSCH (1936a). Specimens assigned to the family

> . . . are fasciculate in form rarely of simple form; generally possess corallites giving an appearance like corals of Clisiophyllidae in the mature stage; they have usually perfect or imperfect peripheral area occupied by lonsdaleoid dissepiments, which area is untravarsed (sic) by any septa. They have much complicated axial structure, built of solid columella, composed of axial tabellae and septal lamellae; all are much thickened by stereoplasmic deposits. Thus the columella of these corals shows apparently features quite similar to that of Amygdalophyllidae on the one side, but also it represents the type of Clisiophyllidae in mature stage as above stated.
>
> Still in the earlier stage, septa of these corals show somewhat pinnate arrangement and the columella is compact, uniting directly with counter septum; besides this the dissepiments are wholly lacking. Thus the corallites present an appearance of lophophylloid corals. (MINATO, 1955, p. 155.)

MINATO also conjectured a lophophyllid ancestry for these corals. Subsequently (in HAYASAKA & MINATO, 1966; MINATO & KATO, 1967) he recognized the cardinal origin of the columella and proposed its derivation from *Amygdalophylloides* DOBROLYUBOVA & KABAKOVICH (1948). To my knowledge, this origin has not been substantiated. Forms now shown to have a columella of cardinal origin are included along with waagenophyllids and aulophyllids in two families by HILL (1956). DOBROLYUBOVA (1962) included geyerophyllids as here defined in the families Geyerophyllidae, Carcinophyllidae, and Koninckocariniidae (COCKE & COCKE, 1968, table 1). A close relationship between the Lonsdaleiidae and Geyerophyllidae is suggested by the excellent work of DEGROOT (1963), who noted that Spanish Carboniferous species of *Lonsdaleia* and *Lithostrotionella* have columellae derived from cardinal septa, as do *Koninckocarinia, Lonsdaleoides, Amygdalophylloides,* and *Carcinophyllum* with the subgenus *Axolithophyllum.*

Similarities and intergradations between geyerophyllid genera make taxonomic assignments difficult. A large number of familial and subfamilial categories have been erected and widespread confusion exists as to generically important characters. Here, familial assignment is based on 1) presence of a lonsdaleoid dissepimentarium, 2) connection of columella to cardinal septum, particularly below the calyx, 3) general external morphology, 4) periaxial sagging of tabulae, and 5) extremely thick epitheca in neanic stage. Relationship between columella and cardinal septum has been noted in relatively few genera, but available data suggest that the cardinal-columella is the unifying factor of these corals. Although further investigation certainly is needed, most described species of the following genera can be included in the Geyerophyllidae: *Koninckocarinia, Axolithophyllum, Kionophyllum, Geyerophyllum, Lonsdaleoides, Carniaphyllum, Carinthiaphyllum, Amygdalophylloides,* and *Heritschiella.* Inclusion of *Carcinophyllum* in this family by COCKE & COCKE (1968) is questionable in view of HILL's emphasis that the cardinal septum forms a fossula in the type species, *C. kirsopianum* THOMSON (1880).

Solitary forms tend to have turbinate shapes and flattened outer calices that deepen into a central area partially occupied by a prominent axial columella. These characters are less pronounced in solitary cylindrical corallites. Fasciculate forms have less widely flaring shapes and more uniformly inclined calice floors. All geyerophyllids are longitudinally ribbed. Internally, lonsdaleoid dissepiments commonly form a prominent peripheral zone. Major and minor septa generally are subequal in length, and in some genera tend to become naotic, particularly in the flat calicular areas. In several genera, the columella of some included species is an extension of the cardinal septum. This structure is the most perplexing feature of the group, and may consist of 1) a simple, unthickened elongation of the cardinal septum, 2) a solid featureless rhopaloid structure, 3) a rhopaloid structure in which a median plate and radiating lamellae are visible within stereoplasmic deposits, 4) a median plate surrounded by thick radiating lamellae interspersed with horizontal to vertical tabellae, or 5) as many as three separate columellae in a single corallite. In a few individuals, the columella is highly contorted or irregularly stellate. The tabularium consists of an outer zone of wide-spaced axially convex plates and an inner zone which may be either sagging or peripherally convex. In neanic stages, the columella is a uniformly thick extension of the cardinal septum; thick peripheral stereoplasmic deposits mask the septal insertion pattern.

North American geyerophyllids as here defined have not been collected extensively from Pennsylvanian rocks except by me and they are unknown from rocks of this continent older than Missourian. Distribution of Missourian geyerophyllids and other dissepimental corals in Kansas is shown in Table 1. I have collected geyerophyllids from equivalent beds in Missouri, Iowa, northeastern Oklahoma and north-central Texas. GIRTY (1915) identified several representatives of the genus from Missourian rocks in the Kansas City area.

Few geyerophyllids are known from Kansas Virgilian rocks, possibly due to inadequate collecting. Except for a small personal collection from the lower Virgilian Clay Creek Limestone, the only Virgilian geyerophyllids have been described by DUNCAN (1962) as *"Axophyl-*

lum" sp. She noted their presence in three Virgilian formations but listed only the Zeandale and Stotler Formations. Ross & Ross (1962) referred a single Virgilian geyerophyllid-like specimen from the Glass Mountains, Texas, to *Lithostrotionella?* sp. In addition, I have a large collection of poorly preserved corallites from a thin limestone in the middle Cisco (Virgilian) of north-central Texas.

The only geyerophyllid species known to me from North American Permian rocks is *Heritschiella girtyi* (Moore & Jeffords) from the Wolfcampian Barneston Limestone of Kansas.

Genus GEYEROPHYLLUM Heritsch, 1936

[*Geyerophyllum* Heritsch, 1936, p. 131]

Type Species.—*Geyerophyllum carnicum* Heritsch, 1936.

Diagnosis.—This genus is composed of solitary to weakly fasciculate corals with a highly variable columella formed by axial elongation and complication of the cardinal septum. Other major septa are long but not generally joined to the columella. Minor septa are absent to strongly developed. Lonsdaleoid dissepiments may be prominent to missing. The tabularium is narrow, with tabulae generally convex toward the apex but in some convex upward or barlike. Exteriors are well marked by longitudinal ridges and grooves.

Discussion.—*Geyerophyllum,* as interpreted here, represents a broad spectrum of morphological types. Five criteria have been used to erect geyerophyllid genera: 1) presence or absence of lonsdaleoid dissepiments, 2) carinate or cavernous septa, 3) habit, 4) character of the columella, and 5) width and character of the dissepimentarium. The range of variation between individuals of several Missourian species crosses most of the above "generic" limits, however. For example, representatives of *Geyerophyllum* sp. cf. *G. broilii* from the Wyandotte formation have 1) a denticulate or smooth columella, 2) a solitary to fasciculate habit, and 3) slightly cavernous to regular septa. Specimens are generally solitary and flaring in the algal-rich calcilutite where they possess rather well-developed lonsdaleoid dissepiments and strongly denticulate columellae. Higher in the formation, particularly in the calcarenite caprock, more specimens are conicocylindrical and may be weakly fasciculate. Here, the columella is less consistently denticulate and lonsdaleoid dissepiments are not present in all individuals.

The range of variation between *Lonsdaleoides* Heritsch (1936a), *Carinthiaphyllum* Heritsch (1936a), *Carniaphyllum* Heritsch (1936a), *Axolithophyllum* Fomichev (1953), *Koninckocarinia* Dobrolyubova (1937), and *Amygdalophylloides* Dobrolyubova & Kabakovich (1948) does not greatly exceed the species variation discussed above. Thus it is believed that these genera could be placed in synonymy with *Geyerophyllum.* Hill (1956), as well as Rowett & Kato (1968) have considered *Geyerophyllum* to be a junior synonym of *Kionophyllum* Chi (1931). However, because information on the type species, *K. dibunum,* is inadequate the two genera are not placed in synonymy at this time.

GEYEROPHYLLUM JEWETTI Cocke, n. sp.

Plate 7, figures 1a-b, 2, 3, 4, 5

Diagnosis.—Corallite shapes of the species vary from broadly turbinate to elongate. The calyx is flat across four-fifths of the diameter but becomes deep and cylindrical at the center. Major septa extend near the columella. No minor septa are present in ephebic stages. The lonsdaleoid dissepimentarium consisting of subrectangular to irregular plates comprises approximately one-half of the corallite diameter. Crests on lonsdaleoid dissepiments represent major septa in some individuals. The columella is a small, generally smooth to slightly denticulate extension of the cardinal septum.

External Characters.—Solitary to loosely fasciculate individuals are elongate to strongly turbinate and longitudinally ribbed, with spines concentrated near attachment surfaces. Diameters range from 18 to 26 mm; septal lengths in most specimens are approximately equal to one-half of the diameter. Calices are divided into two parts: 1) an outer flat area comprised of major septa and dissepiments, and 2) a deep cylindrical central depression with bladelike columella elongated in the counter-cardinal plane.

Transverse Section.—Twenty-two to 26 major septa are well developed in the normal dissepimentarium and thin progressively across the tabularium to terminate a short distance from the columella. Major septa are approximately twice as thick in the outer tabularium as in the normal dissepimentarium. The latter largely consists of incomplete axially convex dissepiments. Minor septa are apparently lacking. In late ephebic stages, the lonsdaleoid dissepimentarium, slightly less than one-half of the corallite diameter, consists of large subrectangular to irregular dissepiments. Most lonsdaleoid dissepiments have crinkly to sinuous boundaries. Rarely do major septa penetrate the lonsdaleoid dissepimentarium except in forms from algal-rich rock of the Hertha phylloid mound complex (see discussion below). A prominent inner wall marks the boundary between the normal and lonsdaleoid dissepimentarium.

Normally, the columella is a smoothly elliptical extension of the cardinal septum; in some specimens, minor protuberances are distributed irregularly along its edges. In one specimen (SUI 33931) two thin columellae are seen.

Longitudinal Section.—Inward from the thin epitheca, the dissepimentarium consists of four to six rows of large gently inclined dissepiments bounded by a prominent inner wall. Anastomosing tabulae are variable

in shape; most are apically convex and incomplete but many are recurved, barlike, or convex distally. The solid columella has an irregularly sinuous outline, with smooth protuberances distributed randomly along its length. Steeply dipping peripherally convex structures partially rim the columella.

Discussion.—Corals assigned to this species have been collected from the normal and algal-mound facies of the Hertha Formation. Also included here in *Geyerophyllum jewetti* are corallites from the algal rock although they differ from those described above in possessing 1) thinner elements, 2) no inner wall, 3) major septa which extend into the lonsdaleoid dissepimentarium, 4) greater size and more slender external shape, and 5) smaller, more densely packed lonsdaleoid dissepiments. However, similarities, particularly lack of minor septa and prominent lonsdaleoid dissepiments, make reasonable their inclusion in this species. It is felt that these two morphotypes are ecological variants of the same species.

The species resembles *Geyerophyllum rude* (White & St. John, 1867) in lack of minor septa and shape of the lonsdaleoid dissepiments, but differs in having a more prominent lonsdaleoid dissepimentarium. *Koninckocarinia concinna* from the Namurian of Spain differs from *G. jewetti* in possessing minor septa and more distinctively arcuate lonsdaleoid dissepiments.

Material Studied.—Approximately 20 specimens were collected from undifferentiated Hertha at Locs. H2, H3, H7, and H8, from which 10 transverse and four longitudinal sections were prepared. The holotype is SUI 33930 and paratypes are SUI 33929 and SUI 33928.

GEYEROPHYLLUM PATULUM Cocke, n. sp.

Plate 7, figures 6a-b, 7a-b

Diagnosis.—This species contains broadly flaring corals characterized by a prominent lonsdaleoid dissepimentarium comprising as much as three-fifths of the corallite diameter and by a loose columella composed of median lamellae and irregular radiating elements. Axially, major septa terminate a short distance from the columella; peripherally, they abut against lonsdaleoid dissepiments. Major septal spines are nonexistent in the outer lonsdaleoid dissepimentarium. Within major septal loculi, minor septa are well developed structures or septal crests on axially convex dissepiments.

External Characters.—Corallites are broadly flaring, with maximum height of 14 mm and maximum width of 32 mm. Smaller specimens are slightly less flaring. The exterior is marked by well-developed septal grooves and interseptal ridges. The calyx consists of a broad outer floor and a deep cylindrical central depression. A prominent boss elongated in the counter-cardinal plane is several millimeters below the outer calicular floor.

Transverse Section.—The number of major septa is 27 at a diameter of 26 mm in the largest specimen. The maximum septal number is 28 at 20.5 mm. The major septa are moderately thick and slightly crooked in the dissepimentarium but progressively thin across the tabularium and terminate near the columella. Minor septa are well developed in some corallites and attain lengths equal to one-half of major septal length. In other specimens, minor septa are represented only by septal crests on apparently normal axially convex dissepiments. The normal dissepimentarium consists of four to six rows of generally complete dissepiments. A faint inner wall marks the juncture of the dissepimentarium and tabularium. The lonsdaleoid dissepimentarium comprises as much as three-fifths of the corallite diameter. Most dissepiments are approximately semicircular or semiellipsoidal; some are large and irregular, with sinuous outlines. In the inner three to four rows, septal crests are aligned with both major and minor septa. Irregular spinelike deposits of stereoplasm unrelated to septal lineation occur on many lonsdaleoid dissepiments. The tabularium is narrow and composed of widely spaced peripherally convex plates. The columella is connected to the cardinal septum. It is oval in outline and consists of a pronounced median lamella and several irregular radiating lamellae. A stereoplasmic rind surrounds the columella.

Specimens from the Bethany Falls Limestone (Swope Formation), and Winterset Limestone (Dennis Formation) differ from Block specimens by lesser development of lonsdaleoid dissepiments. Minor septa are nearly equal in length to major ones. The small columella is comprised of a thick spinose median plate and circumscribing tabellae. Thirty-eight major septa are present at a diameter of 29 mm. Small rounded lonsdaleoid dissepiments occur locally.

Longitudinal Section.—In the upper part of the corallite, elongated dissepiments are inclined at angles of less than 30 degrees but in lower areas the inclination is slightly more than 30 degrees. Along the epitheca, an average of five dissepiments are present in 5 mm. Many dissepiments are thickened by stereoplasmic deposits and may have an irregular spinelike upper surface. The tabularium is filled with widely spaced tabulae highly variable in shape. Most are barlike or convex upward. Steep outwardly curved plates occur sporadically along the axial structure. The columella is irregular in outline and slightly vesicular. An inner wall can be identified in a few areas.

Discussion.—*Geyerophyllum patulum* most closely resembles *G. jewetti* Cocke, n. sp., in possessing a wide lonsdaleoid dissepimentarium. However, the former is differentiated on the basis of 1) more variable columella, 2) lonsdaleoid dissepiments with smoother outlines, and 3) presence of minor septa. Figured specimens of *Cysto-*

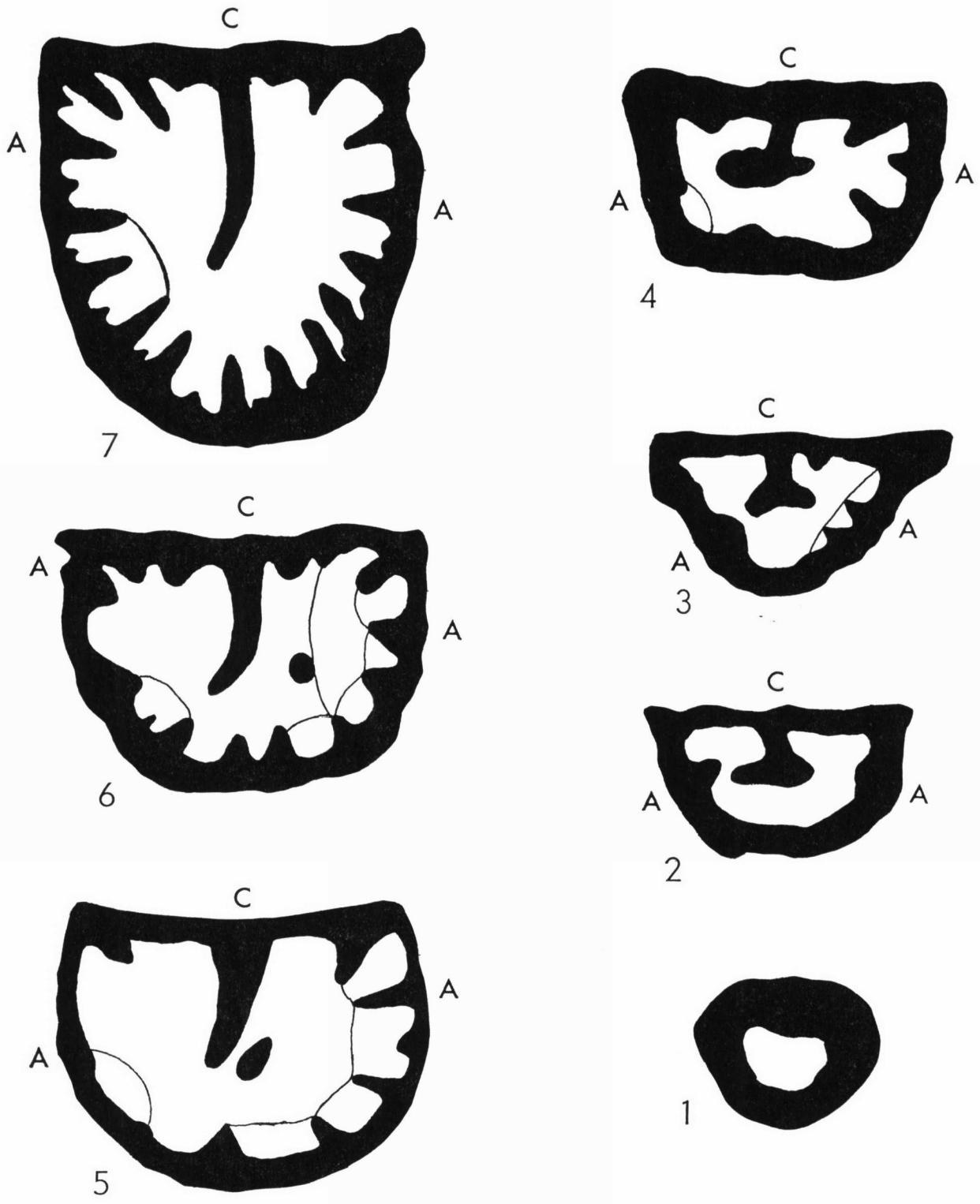


FIG. 9. Serial transverse sections of *Geyerophyllum girtyi* COCKE, n. sp., SUI 33875, all ×19. *(Continued on facing page.)*

phora typica CHI (1931) differ from *G. patulum* in being fasciculate and possessing lonsdaleoid dissepiments.

MATERIAL STUDIED.—Eleven identifiable specimens were collected from the Block Limestone (Cherryvale Formation) at Loc. Bk1, one specimen from the Bethany Falls Limestone (Swope Formation) at Loc. BF7, and several individuals from the Winterset Limestone (Dennis Formation). Three transverse and two longitudinal thin sections were prepared. In addition, several polished sections were examined. Types are holotype SUI 33924 and paratypes SUI 33925 and SUI 33926.

GEYEROPHYLLUM GIRTYI Cocke, n. sp.

Figures 9-10; Plate 7, figures 9a-b, 10a-b

Axophyllum? sp. E GIRTY, 1915, p. 316.
Axophyllum? sp. F GIRTY, 1915, p. 316-317.

DIAGNOSIS.—Geyerophyllids with flaring shapes comprise this species. The calyx has a flat outer area and a center with a deep cylindrical depression. The wide dissepimentarium is composed of angulate elements. Lonsdaleoid dissepiments occur sporadically in late ephebic stages. Major septal length is two-thirds to three-fourths of the corallite radius. Major septa are thin and crooked in the dissepimentarium and thick in the tabularium. The columella is a solid column. Tabulae are narrow and upwardly convex.

EXTERNAL CHARACTERS.—Adult specimens are small and ceratoid to turbinate in shape, ranging in length from 7.5 to 10.5 mm and in diameter from 6 to 10 mm. The outer calyx is flat, with septa and dissepiments visible in well-preserved specimens. A small bladelike columella, elongated in the counter-cardinal plane, lies in a deep cylindrical calyx several millimeters below the outer calicular floor. The epitheca is marked by well-developed longitudinal ridges and grooves and septal spines near the apex.

TRANSVERSE SECTION.—Because of the extreme depth of the central cylindrical depression, all ephebic transverse sections studied are above the tabularium. Major septal lengths range from two-thirds to three-fourths of the corallite radius. In high ephebic stages, major septa numbering 25 to 29 are thin and crooked in the dissepimentarium and double in thickness in the tabularium. The septal formula, determined from a single specimen, is C5A6K7A3. In earlier stages major septa are generally more uniform in thickness. In sections just below the point of lonsdaleoid dissepiment insertion, major septa are thickened peripherally by stereoplasm. Minor septa are generally less than four-fifths of major septal length; in higher sections minor septa are only slightly shorter than major ones. Width of the dissepimentarium is approximately two-thirds of the corallite diameter. Most dissepiments are complete and sharply convex toward the periphery. An inner wall is formed by thickened dissepiments and in some individuals partly by ends of minor septa. Irregularly distributed large lonsdaleoid dissepiments are restricted to late ephebic stages. The columella is small and spindle to oval in shape.

In neanic stages a thick outer wall occupies the position of both dissepimentaria; major septa are stout. Sixteen to 20 major septa are present. Minor septa positions are marked by septa traces in the greatly thickened epitheca. The columella is a stout, slightly spinose extension of the cardinal septum.

Few specimens of *Geyerophyllum girtyi* are suitable for ontogenetic studies and these show considerable variation between individuals. Several general remarks concerning ontogeny of the species are meaningful at this point, however. 1) The epitheca is exceedingly thick in lowest sections and in some corallites comprises two-thirds to three-fourths of its diameter. 2) The cardinal septum originates first as an obscure protuberance on the attachment side of the corallite. It elongates into the center as a simple thick bar. The counter and alar septa are inserted in higher sections. 3) Major septa are inserted in no discernible pattern in the first 2 to 4 mm above the apex. Alars have not been definitely recognized in sections having less than 10 major septa. Indirect evidence suggests that in some specimens they originate adjacent to the cardinal septum and subsequently migrate as majors are inserted in the cardinal loculi. 4) Tabulae are present in early sections but are rare. 5) Minor septa and dissepiments appear late in ontogeny and invariably occur first in counter quadrants. 6) Insertion of early majors is apparently accelerated adjacent to alar septa; after insertion of approximately 10 major septa, insertion occurs almost simultaneously adjacent to cardinal and alar septa. 7) A distinctly pinnate arrangement of major septa is recognizable until approximately 18 major septa are inserted. 8) The columella shows considerable variability. In lower sections it is most commonly a thick simple extension of the cardinal

FIG. 9. *(See facing page.)*

1. Aseptate stage approximately 1 mm in diameter.
2. Section showing T-shaped columella with an ?alar septum on each side, no counter septum apparent; diameter 2.3 mm.
3. Section with 5 major septa including cardinal, 2 alar septa and 2 metasepta, one tabula, diameter near 2.8 mm.
4. Section with counter septum introduced, septal formula C1AK1A1, diameter near 3.0 mm.
5. Section showing auxiliary columella, septal formula C1A1K3A1, diameter near 3.1 mm.
6. Section with auxiliary columella and a few minors in counter quadrants, septal formula C2A3K4A2, diameter near 3.2 mm.
7. Section with minor septa throughout counter quadrants, septal formula ?C3A4K5A2, diameter near 4.0 mm. [*C*, cardinal septum; *A*, alar septum.]

septum but may be recurved, rhopaloid or somewhat denticulate. In each of the two specimens discussed below, an auxiliary columella is present. The presence of auxiliary columellae has been noted in several geyerophyllid specimens from Missourian rocks of Kansas, as well as in *Geyerophyllum rude* (WHITE & ST. JOHN, 1867) from Pennsylvanian rocks of Iowa.

Two specimens from Loc. Dr1 are particularly well preserved and were chosen for ontogenetic studies. Both are narrow and conical for several millimeters from the apex. Rapid expansion occurs above the conical stage.

Differentiated ontogenetic stages of the coral SUI 33875 are as follows:

1) The lowest section (Fig. 9,*1*) has a diameter of 1.8 mm and lies approximately 1 mm above the projected corallite apex. The epitheca comprises slightly less than one-half of the corallite radius in the approximately circular section. No septa are definitely determined; the cardinal appears to be represented by a low protuberance on the inside margin of the epitheca. No septal traces are observed in the epitheca.

2) At a diameter of 2.3 mm, approximately 2.7 mm from the apex, the corallite is semicircular and the epitheca is nearly equal to one-third of the corallite radius (Fig. 9,*2*). The attachment area is shown by a prominent flattened area on the cardinal side of the corallite. The cardinal septum extends into the central area as a thick septal wedge. Two low ridges simulate septal protuberances. No tabulae, dissepiments, or minor septa are present.

3) Four major septa, including a wedge-shaped cardinal columella, are present at a diameter of 2.8 mm, approximately 3.2 mm from the projected apex (Fig. 9,*3*). They are scattered sporadically along the inner epithecal margin. Septal traces can be observed in the epitheca. Two peripheral tabulae are observed.

4) At a section 3.4 mm from the projected apex, with diameter of 3.0 mm, six major septa are present (Fig. 9,*4*). The columella is irregularly T-shaped. Two tabulae are seen. Only the cardinal septum can be identified definitely. A probable septal formula is CAK1A1.

5) Sections between diameters of 3.0 and 3.9 mm (Fig. 9,*5-6*) show an increase in septal number from 10 to 15. The major septa remain short. A pattern of insertion is identified definitely. A probable septal formula at a diameter of 3.2 mm is C2A3K4A2. The columella becomes a simple thickened bar in contrast to an earlier T-shape. One arm of the columella atrophies, the other persisting as an oval to circular auxiliary columella isolated from the cardinal columella. It disappears at a diameter near 3.7 mm. Minor septa first appear in a few interseptal spaces in the counter quadrants at a diameter of 3.4 mm and are in all spaces in the counter quadrant at a diameter of 3.9 mm.

6) At a diameter approximately 4 mm above the projected apex, 18 major septa are represented by a septal formula of C3A4K5A2 (Fig. 9,*7*). Minor septa are present in all interseptal spaces in the counter quadrants and one minor septum is observed in the cardinal quadrant. Dissepiments are lacking.

Ontogenetic stages of the second specimen (SUI 33874) generally are similar to those of the specimen described above and will not be discussed in detail (Fig. 10).

A short distance above the highest illustrated section of both specimens, a prominent inner wall forms at inner ends of minor septa. It blends with the epitheca in the cardinal quadrants where minor septa are absent. As minor septa are introduced, the inner wall extends across these quadrants.

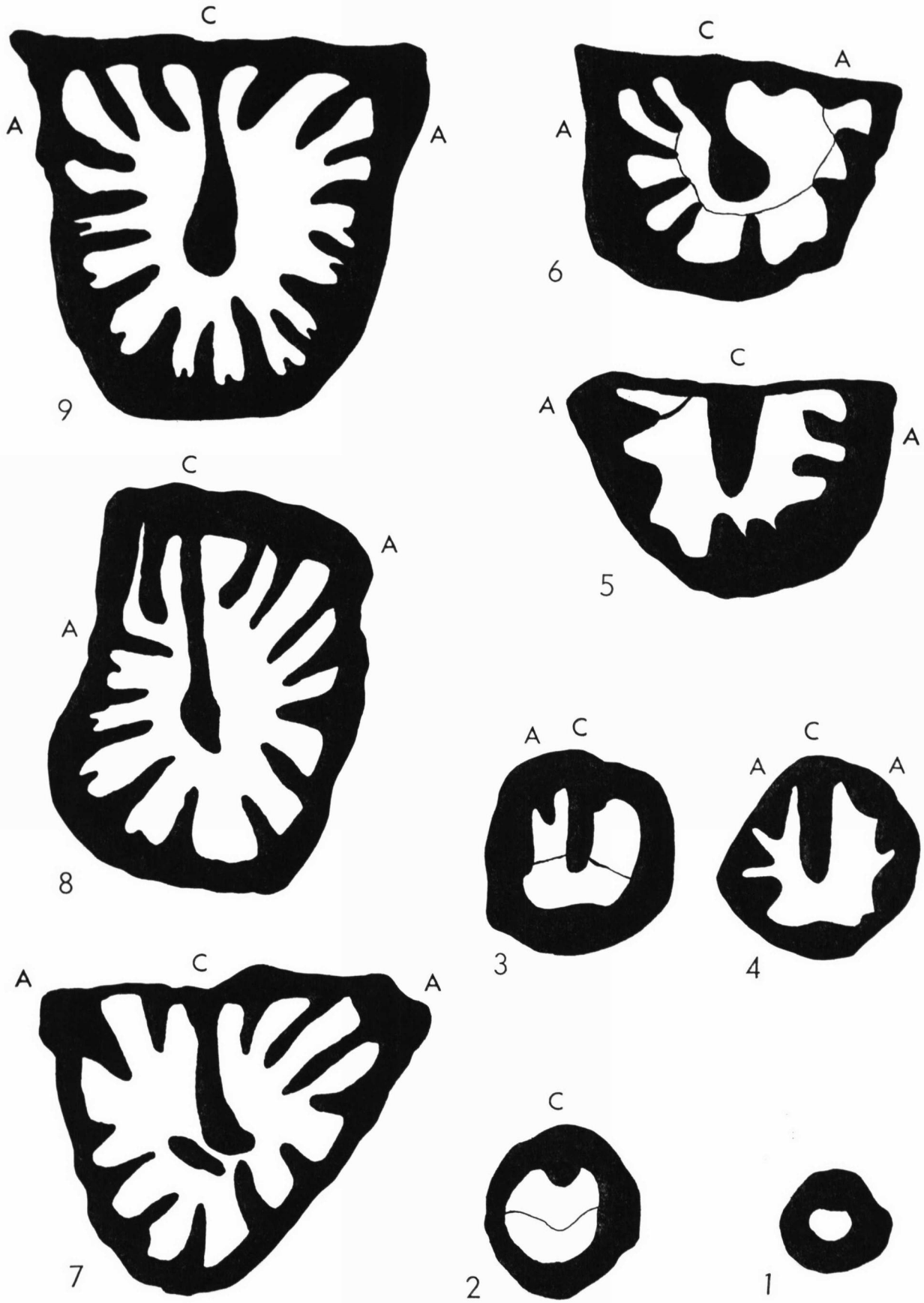
LONGITUDINAL SECTION.—Dissepiments are elongate, with inclination subparallel to the epitheca; four or five dissepiments occur in 5 mm along the epitheca. An inner wall is present on the innermost dissepiments. The tabularium is narrow and largely comprised of upwardly convex tabulae inclined against the inner wall. Seven are present in 5 mm. Elongate, peripherally convex structures occur sporadically along the columella. The solid columella varies considerably in thickness.

DISCUSSION.—*Geyerophyllum girtyi* differs from *G. jewetti* COCKE, n. sp., and *G. patulum* COCKE, n. sp., in lacking a prominent lonsdaleoid dissepimentarium. It differs from *G. rude* (WHITE & ST. JOHN, 1867) from Pennsylvanian rocks of Iowa in possessing pronounced minor septa and less prominently developed lonsdaleoid dissepiments.

MATERIAL STUDIED.—Approximately 50 specimens were collected from Locs. Dr1 and Dr2 of the Cement City Limestone. Twenty transverse and six longitudinal specimens were prepared. Type specimens are the holo-

FIG. 10. Serial transverse sections of *Geyerophyllum girtyi* COCKE, n. sp., SUI 33874, all ×16. *(See facing page.)*

1. Aseptate stage at 0.9 mm diameter.
2. Section with cardinal septum and single tabula, diameter near 2.0 mm.
3. Section with alar septa present on each side of cardinal columella, diameter of 2.1 mm.
4. Section showing septal acceleration in counter quadrants, septal formula CA2K3A, diameter near 3.4 mm.
5. Section showing further insertion of major septa in alar quadrants.
6. Section with major septa inserted in cardinal quadrant, septal formula is C1A2K2A1.
7. Section showing elongate auxiliary columella, septal formula C1A3K3A2, diameter near 3.7 mm.
8. Section of corallite at neanic stage showing minor septa (inner wall deleted for clarity) septal formula C2A4K5A2, diameter near 4.2 mm.
9. Section of corallite at neanic stage with minor septa in most alar quadrant loculi. [*C*, cardinal septum; *A*, alar septum.]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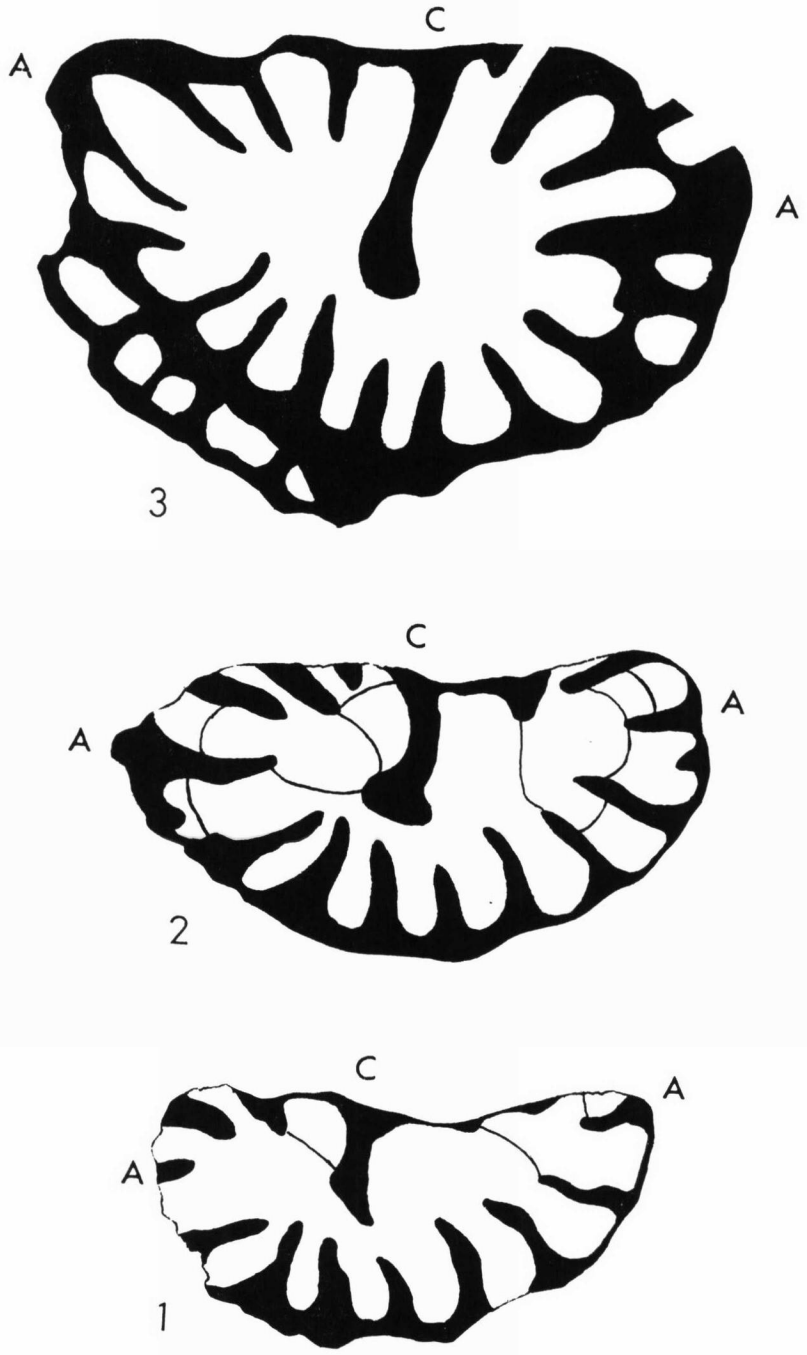


FIG. 11. Serial transverse sections of the neanic stage of *Geyerophyllum* sp. cf. *G. broilii* HERITSCH (1936a) from Plattsburg Limestone at Loc. Pb1, all ×18.——*1*. Section with 14 major septa; septal formula C2A3K3A2.——*2*. Section showing insertion of one major septum on each side of the alar septa; septal formula C3A4K4A2.——*3*. Section with 18 major septa with addition of a major septum adjacent to the cardinal-columella, septal formula C3A4K4A3; note vesicles on inner side of epitheca. [*C*, cardinal septum; *A*, alar septum.]

type SUI 33923 and paratypes SUI 33922 and SUI 33921.

GEYEROPHYLLUM sp. cf. G. BROILII Heritsch, 1936

Figure 11; Plate 8, figures 1a-b, 2, 3, 4, 5, 6, 7a-b, 8, 9a-b, 10

?*Geyerophyllum broilii* Heritsch, 1936, p. 133, pl. 18, fig. 6, 14-15; text. fig. 38.

Diagnosis.—Subcylindrical to gently flaring corallites are included in *Geyerophyllum* sp. cf. *G. broilii*. Major septa are thin to faintly lanceolate and minor ones have similar shapes. Dissepiments are moderately packed and slightly angulate. An obscure inner wall is present in a few specimens. The columella is quite variable, ranging in shape from oval to stellate. The lonsdaleoid dissepimentarium consists of 1) thin closely packed, gently curved dissepiments in a persistent zone or 2) large, irregular, highly curved structures distributed sporadically along the periphery.

External Characters.—Most corallites are subcylindrical, with adult diameters near 10 mm. Conical forms have diameters up to 15 mm. Calices are deep and conical. The columella forms a broad blade in the center of the calyx. Major and minor septa, approximately equal in length at late ephebic stage, are visible in well-preserved calices.

Transverse Section.—In ephebic stages major septa number between 25 and 28; the septal formula is approximately C5A7K7A5. Majors vary from thin to slightly lanceolate and cross between two-thirds to four-fifths of the corallite diameter. Minor septa are slightly thinner than major ones and equal two-thirds to three-fourths of major septal lengths. The dissepimentarium, approximately one-half of the corallite diameter, is composed of an outer series of moderately angulate, peripherally convex dissepiments which merge with an inner row of incomplete anastomosing dissepiments. An obscure inner wall occurs in a few specimens. Most tabulae are straight but a few are gently curved. The columella is smoothly elliptical to irregular and represents an extension of the cardinal septum. The lonsdaleoid dissepimentarium may be composed of 1) very thin closely spaced dissepiments which are gently curved, or 2) irregular, large, highly curved structures.

At diameters near 5 mm approximately 18 major septa extend across more than three-fourths of the corallite radius. They are thick throughout the length if not interrupted by sporadically distributed lonsdaleoid dissepiments. Minor septa are wedgelike spines extending a short distance axially from the thickened epitheca. The normal dissepimentarium, where present, consists of two rows of axially convex dissepiments. The columella is a rhopaloid extension of the cardinal septum.

A single weathered specimen from the Spring Hill Limestone (Plattsburg Formation) was sectioned serially in order to study neanic stages (Fig. 11). The sections resemble those from similar stages of *Geyerophyllum girtyi* Cocke, n. sp., from the Cement City Limestone in possessing both thickened epitheca and major septa and in showing an early septal acceleration in alar quadrants. No specimens studied show earlier stages.

In the lowest section studied at a diameter of 3 mm and a projected distance from the apex of 5 mm, 14 major septa are present. The cardinal septum extending to the center of the corallite as a thickened bar is wedge-shaped near this axis. Other major septa are thick and extend one-half to three-fourths across the corallite radius. None reach the cardinal columella. A septal formula of C2A3K3A2 shows a nearly equal development of major septa in cardinal and counter quadrants; however, shortness of septa in the former indicates an earlier insertion of septa in cardinal quadrants. The earlier septal formula probably was C1A3K3A1. A pinnate pattern in the major septa is discernible. A few tabulae are present.

At a diameter of 3.7 mm (Fig. 11,2) the section is similar to that just discussed except for the addition of three major septa, two on counter sides of the alar septa and one inserted adjacent to the cardinal septum. Seven tabulae are intersected.

Sections between 3.7 and 4.3 mm show a proportional shortening of major septa and the first appearance of vesicles in the epitheca. Tabulae increase in number. The columella changes from a wedgelike structure to a simple rhopaloid extension of the cardinal septum. At a diameter of 4.3 mm, 18 major septa are represented by a formula of C3A4K4A3. The major septa have retreated slightly from the center. Vesicles adjacent to the epitheca separate the epitheca from the inner wall.

Longitudinal Section.—Six to eight rows of moderately inclined dissepiments form the peripheral one-half of the corallite radius. The inner rows of dissepiments are steeply inclined and may have minor amounts of stereoplasm. Outer tabulae are large and incline in the same direction but at lesser angles than outer dissepiments. Inner tabulae anastomose and may be sagging, horizontal, or upwardly convex. The columella is an irregular cylinder with a distinct median line.

Discussion.—The species ranges throughout the Argentine Limestone and Farley Limestone Members of the Wyandotte Formation, as well as the normal facies and northern algal-mound complex of the Spring Hill Member of the Plattsburg Formation. Considerable variation is present locally. The Argentine forms are solitary, gently flaring, possess a stellate columella, and exhibit lanceolate major septa. Conicocylindrical forms increase in number in the Farley. Specimens possessing a stellate columella become progressively less abundant and almost nonexistent near the top of the Farley, except at the top of the algal limestone at Loc. Wy3 where all

specimens possess strongly stellate columellae throughout late ontogeny. Many individuals occur in loose colonies. Laterally, in equivalent beds, stellate characters become progressively less pronounced and are almost nonexistent at Loc. Wy1 a few miles to the west. This character is present in a few Spring Hill members of the species.

Geyerophyllum sp. cf. *G. broilii* is most similar to *G. garnettense* Cocke, n. sp., and the two species as here defined may represent ecological variants of a single species. Because morphological intermediates have not been discovered, specimens are placed in two different species. The latter occurs only at a single locality, Pb5, in the Spring Hill Limestone. *G.* sp. cf. *G. broilii* possesses a more prominent lonsdaleoid dissepimentarium composed of large rounded to subrectangular plates and less angulate dissepiments in the normal dissepimentarium.

Morphological attributes of specimens described here agree closely with those of *Geyerophyllum broilii (sensu stricto)* except that specimens figured by Heritsch from the Uralian of the Carnic Alps show more consistently complex columellae and less strongly curved dissepiments. *Carinthiaphyllum kahleri,* from the *Pseudoschwagerina* zone of the Carnic Alps, possesses few lonsdaleoid dissepiments but has major septa which reach almost to the columella.

Material Studied.—Over 200 specimens were collected from the following localities: Wy1, Wy2, Wy3, Wy5, Wy8, Wy9, Wy10, Wy11, W12, Pb1, Pb2, Pb3, Pb4, and Pb6. Figured specimens are SUI 33914, SUI 33913, and SUI 33912.

GEYEROPHYLLUM GARNETTENSE Cocke, n. sp.

Plate 8, figures 11a-b, 12a-b, 13

Diagnosis.—The species includes solitary or perhaps fasciculate corallites gently flaring to subcylindrical in shape. Major septa are lanceolate and thick. Minor septa are approximately three-fourths of major septal length and tend to thicken near their axial extremities. Dissepiments are closely packed, angulate, and peripherally convex. Thin, closely packed, elongate lonsdaleoid dissepiments form the peripheral zone. The columella is a simple slightly thickened extension of the cardinal septum.

External Characters.—Corallites are narrowly conical to subcylindrical. Ephebic diameters range from 8 to 16 mm and lengths reach 45 mm. Longitudinal ribbing is prominent and rejuvenescence rare. The cylindrical calyx is deep, with a bladelike axial boss in the cardinal-counter plane. A small subtriangular attachment area partially rimmed by knobs and spines may be located on the convex side of curvature. The species is highly gregarious; packing in limestone matrix suggests a fasciculate growth habit. A few budded individuals were collected.

Transverse Section.—In ephebic stages major septa number approximately 26 at 15 mm and traverse approximately three-fourths of the corallite diameter. Septal formula is C3A6K6A4. Major septa are thick and lanceolate. Minor septa with similar shapes are one-half to three-fourths of major septal length. Closely spaced dissepiments which abut against major septa at low angles lend a scaly appearance to the septa. The dissepimentarium comprises one-third to one-half of the corallite diameter. Dissepiments are extremely closely spaced, peripherally angulate, and thickened by stereoplasmic deposits. Outermost angulate dissepiments interrupt both major and minor septa near the periphery. One specimen possesses a prominent inner wall; others have varying amounts of stereoplasm on scattered inner dissepiments. Closely spaced, gently curved lonsdaleoid dissepiments form a narrow peripheral band. The tabularium consists of barlike, peripherally convex and axially convex tabulae. The columella is either isolated or connected to the cardinal septum. Typically, it is lath-shaped or narrowly elliptical; a few protuberances are present in some specimens. Two columellae observed in a few specimens are elongate, simple, and lie parallel to each other.

In neanic stages at a diameter between 4.5 to 6.0 mm, the columella is invariably connected to the cardinal septum; 16 to 19 major septa are present. Major and minor septa are extremely thick, the latter obscured by epithecal deposits. No dissepiments are present. The epitheca comprises one-third of the corallite diameter.

Longitudinal Section.—As many as six rows of steeply inclined dissepiments comprise the dissepimentarium. Dissepiments are more steeply inclined near the junction with the tabularium. An inner wall, obscure or absent in late ephebic stage, becomes prominent in lower portions of the corallite. Outer tabulae are extremely steep, axially convex, and large. The inner tabularium consists of anastomosing short plates which are barlike, sagging, and convex outward. The columella is broad in early stages but progressively narrows upward. Cone-in-cone growth increments and an indistinct median line are seen in the columella.

Discussion.—Separation of this species from *Geyerophyllum* sp. cf. *G. broilii* Heritsch (1936a) may be unrealistic because both occur approximately in the same stratigraphic position in the Spring Hill Limestone of the Plattsburg Formation where they are accompanied by similar organisms and are separated only a few miles geographically. With the development of new exposures, intermediate forms may be found. (See discussion of *Geyerophyllum* sp. cf. *G. broilii.*)

Material Studied.—Approximately 30 specimens were collected from Loc. Pb5. Twenty-five transverse and 12 longitudinal sections were prepared. The holotype is SUI 33917 and paratypes are SUI 33916 and SUI 33915.

GEYEROPHYLLUM CYLINDRICUM (Dobrolyubova & Kabakovich, 1948)

Plate 8, figures 14a-b, 15

Axophyllum cylindricum Dobrolyubova & Kabakovich, 1948, p. 32, pl. 15, fig. 1-5; pl. 16, fig. 1-3.

Carcinophyllum (Axolithophyllum) aff. *cylindricum* DeGroot, 1963, p. 100, pl. 25, fig. 1.

non Axophyllum cylindricum Girty, 1915, p. 308.

Diagnosis.—This species consists of gently flaring to cylindrical individuals with strong longitudinal ribbing. Major septa, numbering 27, are strongly lanceolate. Minor septa are approximately two-thirds of major septal length and are blunt. An impersistent inner wall is present. Columellae are highly variable; most are denticulate and a few smoothly elliptical. No lonsdaleoid dissepiments have been observed in ephebic stages. Longitudinal sections are typically geyerophyllid in showing a peripheral zone of dissepiments, central columella, and two-part tabularium consisting of an outer zone of steeply inclined plates against the inner wall and inner zone of anastomosing sagging to convex tabulae.

External Characters.—All observed specimens are imbedded in calcarenite; hence external characters must be inferred from sectioned material. Specimens are longitudinally ribbed and apparently moderately flaring.

Transverse Section.—The epitheca is thick, with external ridges marking interseptal spaces. Major septa number approximately 27 in the ephebic stage and terminate peripherally on well-defined internal ridges. They are lanceolate, attaining maximum thickness at a point two-thirds of the distance from the periphery. The septal formula is C5A7K6A5. Minor septa are blunt to faintly lanceolate and one-half to two-thirds of major septal length. Dissepiments are widely spaced, complete and peripherally convex. Width of the dissepimentarium is approximately one-third of the corallite diameter. An impersistent inner wall marks the intersection between the tabularium and dissepimentarium. No lonsdaleoid dissepiments have been observed in the ephebic stage. Tabulae are both axially and peripherally convex; a few are straight. The columella is variable. Commonly it is a solid structure with a median line from which septal lamellae radiate; interstices are filled with stereoplasm. In the specimen SUI 33914 and a few other specimens, the columella is composed of a median lamella with irregular thick radiating protuberances which are circumscribed by a thickened tabellar rind.

At a diameter near 6 mm approximately 17 major septa are counted. The septal formula for one specimen is C3A4K4A2. Major septa are less strongly lanceolate. Minor septa are less than one-half of major septal length and only faintly lanceolate. A few irregular lonsdaleoid dissepiments occur sporadically. The columella tends to be smoother than in higher sections. At a diameter near 5 mm, a transverse section of the holotype possesses 18 major septa. The epitheca is equal in thickness to one-fourth to one-third of the diameter. Minor septa are visible as faint lines in the epitheca. The columella is large and solid, with a few coarse protuberances.

Longitudinal Section.—Longitudinal sections show typical geyerophyllid characters: 1) peripheral zone of dissepiments, 2) outer tabularium in which tabulae are inclined against the inner wall, 3) inner tabularium of anastomosing tabulae which may be barlike or convex either upward or downward, and 4) a central columella. Of the longitudinal sections cut, only one specimen has a perforate columella which is composed of irregular intersections of the median lamella, radiating lamellae, and small intercolumellar sagging tabulae.

Discussion.—Individuals of *Geyerophyllum cylindricum* are somewhat similar to Wyandotte representatives of *G.* sp. cf. *G. broilii* which have lanceolate major septa and a complex columella. They differ in possessing more strongly pronounced lanceolate septa and generally in lacking lonsdaleoid dissepiments. North American representatives differ from type specimens of *Axophyllum cylindricum* Dobrolyubova & Kabakovich (1948) from upper Moscovian beds of the Moscow Basin in possessing fewer major septa and in more flaring shape of the corallites. Figured specimens of *Carcinophyllum (Axolithophyllum)* aff. *cylindricum* described by DeGroot (1963) from the Cotarraso Limestone, Westphalian of Spain, possesses more major septa but the columella is similar. *Amygdalophylloides ivanovi* (Dobrolyubova, 1937), from the Upper Carboniferous of the Moscow Basin, is similar to North American representatives of *G. cylindricum* in lacking lonsdaleoid dissepiments but differs in having a simple smooth columella and conico-cylindrical shape. In addition, the Russian species has a less-developed normal dissepimentarium. *Carinthiaphyllum carnicum* Heritsch (1936a) from the *Triticites* Zone of the Carnic Alps is separated from the forms discussed here by an ontogenetic stage in which several majors reach the central area.

Material Studied.—Approximately 50 specimens were collected from Locs. St1, St3, St16, and St20. Twelve transverse and three longitudinal sections were prepared.

GEYEROPHYLLUM sp. A

Plate 7, figure 8

A single small fragment of an interesting geyerophyllid (SUI 33927) was collected from the Bethany Falls in NE SE sec. 24, T. 18 N., R. 24 E., Miami County, Kansas. Transverse sections show 22 short major septa which peripherally abut against lonsdaleoid dissepiments. Minor septa are spinelike. The lonsdaleoid dissepimentarium comprising two-fifths of the corallite diameter is composed of very large subrectangular to irregular plates on which septal crests are present. The inner margin is

marked by a thick inner wall. No tabulae have been observed. The columella consists of an elongated cardinal septum thickened in the axial region and possessing a few irregular lamellae.

Discussion.—This form resembles the early neanic stage of *Koninckocarinia concinna* DeGroot (1963) from the Spanish Namurian in possessing large lonsdaleoid dissepiments and a simple columella but differs in having shorter minor septa and fewer major septa. It is possible that the specimen is an immature stage of a larger coral. However, the presence of prominent lonsdaleoid dissepiments is in striking contrast to lack of these structures in early stages of Pennsylvanian geyerophyllids of North America.

REFERENCES

Armstrong, A. K., 1962, *Stratigraphy and paleontology of the Mississippian system in southwestern New Mexico and adjacent southeastern Arizona:* New Mexico Inst. Min. Technology, Mem., v. 8, p. i-vi, 1-99, 41 text fig., 12 pl.

Beede, J. W., 1900, *Carboniferous invertebrates:* Kansas Geol. Survey, v. 6, pt. 2, 187 p.

Bell, W. A., 1929, *Horton-Windsor District, Nova Scotia:* Geol. Survey Canada, Mem., no. 155, 268 p., 36 pl.

Benson, W. N., & Smith, S., 1923, *On some rugose corals from the Burindi Series (Lower Carboniferous) of New South Wales:* Geol. Soc. London, Quart. Jour., v. 79, p. 156-171, pl. 8-9.

Bilelo, M. A. M., 1967, *Fusulinidae of the Winchell Formation (Pennsylvanian) in the Brazos River Valley and part of the Trinity River Valley, north-central Texas:* Unpub. master's thesis, Southern Methodist Univ.

———, 1969, *Fusulinidae of the Winchell Formation (Pennsylvanian), north-central Texas:* Jour. Paleontology, v. 43, no. 3, p. 688-704, 2 text fig., pl. 85-87.

Chi, Y. S., 1931, *Weiningian (Middle Carboniferous) corals of China:* Palaeont. Sinica, ser. B, v. 12, fasc. 5, 70 p., 5 pl.

Cocke, J. M., 1966, *New species of* Dibunophyllum *from the Dewey Formation:* in Studies of Pennsylvanian corals in Oklahoma, Oklahoma Geol. Survey, Circ. 72, pt. 2, p. 35-56.

———, 1969, *Taxonomic and environmental study of two dibunophyllid coral species from Upper Pennsylvanian rocks of Kansas:* Univ. Kansas Paleont. Contrib., Paper 44, p. 1-11, text fig. 1-5.

———, & Cocke, N. C., 1968, *Classification and distribution of Missourian (Upper Pennsylvanian) geyerophyllid corals from Kansas:* Kansas Acad. Sci., Trans., v. 71, no. 1, p. 38-48, 1 pl.

———, & ———, 1969, *Redescription of a Pennsylvanian geyerophyllid coral species from Iowa:* Jour. Paleontology, v. 43, no. 4, p. 941-946, pl. 114.

Crowley, D. J., 1966, *Paleoecology of an algal carbonate bank complex in the Late Pennsylvanian Wyandotte Formation of eastern Kansas:* Unpub. doctoral dissertation, Brown Univ., 182 p.

De Groot, G. E., 1963, *Rugose corals from the Carboniferous of northern Valencia (Spain):* Leidse Geol. Meded., Deel 29, 123 p., 26 pl.

Dobrolyubova, T. A., 1937, *Simple corals of the Myatshkovo and Podolsk horizons of the Middle Carboniferous of the Moscow Basin:* Inst. Paléozool., Acad. Sci. URSS, Trav., v. 6, livr. 3, 92 p., 23 pl. (in Russian, English summary, p. 72-81).

———, 1962, *Spravochnik dlya paleontologov i geologov SSSR: gubki, arkheotsiaty, kishechnopolostyne, chervi* [Bases of paleontology, sponges, archaeocyathids, coelenterates, worms]: in B. S. Sokolov (ed.), Osnovy Paleontologii, Isdatel. Akad. Nauk SSSR Moskva, p. 327-332.

———, & Kabakovich [Kabakovitch], N., 1948, *Nekotorye predstaviteli Rugosa srednego i verkhnego karbona Podmoskovnogo basseina* [Some representatives of the Rugosa in the Middle and Upper Carboniferous of the Moscow Basin]: Acad. Sci. URSS, Inst. Paléont. Trav., v. 14, no. 2, p. 1-37, 16 pl.

Duncan, Helen, 1962, *Phylum Coelenterata:* in M. R. Mudge, & E. L. Yochelson, Stratigraphy and paleontology of the uppermost Pennsylvanian and lowermost Permian rocks in Kansas: U.S. Geol. Survey, Prof. Paper 323, p. 64-66, pl. 11.

Dybowski, W. N., 1873-74, *Monographie der Zoantharia sclerodermata rugosa aus der Silur-formation Estlands, Nord-Livlands und der Insel Gotland, nebst einer Synopsis aller palaeozoischen Gattungen dieser Abteilung und einer Synonymik der dazu gehörigen, bereits bekannten Arten:* Archiv Naturk., Liv-, Est-, u. Kurlands, ser. 1, v. 5, p. 257-532, pl. 1-5.

Easton, W. H., 1943, *The fauna of the Pitkin Formation of Arkansas:* Jour. Paleontology, v. 17, no. 2, p. 125-154, pl. 21-24.

———, 1944, *Revision of* Campophyllum *in North America:* Same, v. 18, no. 2, p. 119-132, pl. 22.

———, 1960, *Permian corals from Nevada and California:* Same, v. 34, p. 570-583, 18 text fig.

———, 1962, *Carboniferous formations and faunas of central Montana:* U.S. Geol. Survey, Prof. Paper 348, 146 p., 14 pl.

Fagerstrom, J. A., & Eisele, C. R., 1966, *Morphology and classification of the rugose coral* Pseudozaphrentoides verticillatus *(Barbour) from the Pennsylvanian of Nebraska:* Jour. Paleontology, v. 40, no. 3, p. 595-602, 4 text fig., pl. 73.

Fleming, John, 1828, *A history of British animals:* Edinburgh, xxii + 565 p.

Fomichev [Fomitchev], V. D., 1939, *Tip Kishechnolostnye* [Coelenterata]: in I. Gorsky (ed.), Atlas rukovodyashchikh form iskopaemykh faun SSSR, v. 5, Sredniy i verkhniy otdely Kamennougolnoy sistemy [Atlas of the leading forms of the fossil faunas of USSR, v. 5, Middle and upper Carboniferous], Tsentralnyi Nauchno-issledov. Geol.-Razved. Inst. [Central Geol. Prosp. Inst. Leningrad], p. 50-64, pl. 6-11.

———, 1953, *Korally Rugosa i stratigrafiya sredne i verkhnekamennougolnykh i Permiskikh otlozhenii Donetzkogo Basseina* [Rugose corals and stratigraphy of middle and upper Carboniferous and Permian deposits of the Donetz Basin]: Vses. Nauch-Issledov. Geol., Trudy (VSEGEI), Min. Geol. Moscow, 622 p., 44 pl.

FRAUNFELTER, G. H., 1965, *A new Pennsylvanian dibunophyllid coral from Missouri:* Missouri Geol. Survey, Rept. Invest. no. 32, 8 p., 1 text fig.

GERVAIS, PAUL, 1840, *Astrée, Astraea:* in Dictionnaire des sciences naturelles, Suppl., Paris, v. 1, p. 481-487.

GIRTY, G. H., 1915, *Invertebrate paleontology of the Pennsylvanian of Missouri:* Missouri Bur. Geol. Mines, ser. 2, v. 13, p. 263-376.

GRABAU, A. W., 1922, *Paleozoic corals of China, Part I, Tetraseptata:* Palaeont. Sinica (Geol. Survey China), ser. B, v. 2, fasc. 1, 76 p., 1 pl.

HATTIN, D. E., 1957, *Depositional environment of the Wreford megacyclothem (Lower Permian) of Kansas:* Kansas Geol. Survey, Bull. 124, 150 p.

HAYASAKI, I., 1924, *On the fauna of the anthracolithic limestone of Omi-mura in the western part of Echigo:* Tohoku Univ., Sci. Rept., 2nd ser. (Geol.), v. 8, no. 1, 83 p., 7 pl.

———, & MINATO, M., 1966, *On* Lonsdaleoides nishikawai *n. sp. (On Upper Paleozoic fauna from Miharanoro, Hiroshima Prefecture, Japan, 2nd note):* Hokkaido Univ., Jour. Fac. Sci., ser. 4, v. 13, no. 3, p. 273-280.

HECKEL, P. H., 1966, *Relationship of carbonate facies in an algal-mound complex in Upper Pennsylvanian of Kansas:* Geol. Soc. America, Ann. Meeting, San Francisco, p. 90-91 (abstr.).

———, & COCKE, J. M., 1969, *Phylloid algal mound complexes in outcropping Upper Pennsylvanian rocks of Mid-Continent:* Am. Assoc. Petroleum Geologists, Bull., v. 53, no. 5, p. 1058-1074.

HERITSCH, FRANZ, 1936a, *Korallen der Moskauer-, Gshel-, und Schwagerinen-Stufe der Karnischen Alpen:* Palaeontographica, v. 83A, no. 3-6, p. 99-162, text fig. 1-6, pl. 14-18.

———, 1936b, *A new rugose coral from the Lower Permian of Texas, with remarks on the stratigraphical significance of certain Permian coral genera:* Am. Jour. Sci., v. 32, p. 134-144, 2 pl.

———, 1941, "Clisiophyllum" *aus dem Oberkarbon:* Zentralbl. Mineralogie, Geologie, Paläontologie, 1941, B, p. 129-138, 10 text fig.

HILL, DOROTHY, 1938, *The Carboniferous rugose corals of Scotland:* Palaeontograph. Soc., Mon., 213 p., 11 pl.

———, 1956, *Rugosa:* in Coelenterata, Part F, Treatise on invertebrate paleontology, R. C. Moore (ed.), Geol. Soc. America and Univ. Kansas Press, New York, Lawrence, Kansas, p. *F*233-*F*323.

JEFFORDS, R. M., 1942, *Lophophyllid corals from Lower Pennsylvanian rocks of Kansas and Oklahoma:* Kansas Geol. Survey, Bull. 41, pt. 5, p. 185-260, text fig. 1-2, pl. 1-8.

———, 1947, *Pennsylvanian lophophyllidid corals:* Univ. Kansas Paleont. Contrib., Coelenterata, Art. 1, p. 1-47, text fig. 1-9, pl. 1-28.

———, 1948a, *New Pennsylvanian dibunophyllid corals (Oklahoma-Kansas):* Jour. Paleontology, v. 22, no. 5, p. 617-623, 11 text fig.

———, 1948b, *The occurrence of corals in the Late Paleozoic rocks of Kansas:* Kansas Geol. Survey, Bull. 76, pt. 3, p. 31-52, 4 pl.

KEYES, C. R., 1894, *Paleontology of Missouri, Pt. 1:* Missouri Geol. Survey, v. 4, 271 p.

MERRIAM, C. W., 1942, *Carboniferous and Permian corals from central Oregon:* Jour. Paleontology, v. 16, p. 372-381, pl. 54-57.

MICHELIN, HARDOUIN, 1840, *Iconographie zoophytologique, description par localités et terrains des polypiers fossiles de France et pays environnants:* P. Bertrand, Paris, 334 p., 79 pl.

MILLER, S. A., & GURLEY, W. F. E., 1893, *Descriptions of some new species of invertebrates from the Paleozoic rocks of Illinois and adjacent states:* Illinois State Museum Nat. History, Bull. 3, 81 p., 7 pl.

MILNE-EDWARDS, H., & HAIME, JULES, 1850-54, *British fossil corals:* Palaeontograph. Soc., Mon., Introduction and pt. 1 (1850), p. i-lxxxv, 7-71; pt. 2 (1851), p. 73-145; pt. 3 (1852), p. 147-210; pt. 4 (1853), p. 211-244; pt. 5 (1854), p. 245-299.

MINATO, M., 1955, *Japanese Carboniferous and Permian corals:* Hokkaido Univ., Jour. Fac. Sci., v. 4, Geol. Min., v. 9, no. 2, 202 p., 43 pl.

———, & KATO, M., 1965a, *Durhaminidae (tetracoral):* Hokkaido Univ., Jour. Fac. Sci., ser. 4, v. 13, no. 1, p. 11-86, 5 pl.

———, & ———, 1965b, *Waagenophyllidae:* Same, ser. 4, v. 12, no. 3-4, 241 p., 20 pl.

———, & ———, 1967, *On the coral genus* Carinthiaphyllum *Heritsch, with a description of* Carinthiaphyllum carnicum *Heritsch from the Carnic Alps:* Same, ser. 4, v. 13, no. 4, p. 313-320, pl. 38.

MOORE, R. C., 1935 (1936), *Stratigraphic classification of the Pennsylvanian rocks of Kansas:* Kansas Geol. Survey, Bull. 22, 256 p.

———, 1948, *Classification of Pennsylvanian rocks in Iowa, Kansas, Missouri, Nebraska, and northern Oklahoma:* Am. Assoc. Petroleum Geologists, Bull., v. 32, no. 11, p. 2011-2040.

———, & JEFFORDS, R. M., 1941, *New Permian corals from Kansas, Oklahoma, and Texas:* Kansas Geol. Survey, Bull. 38, pt. 3, p. 65-120, 8 pl.

———, & ———, 1945, *Descriptions of Lower Pennsylvanian corals from Texas and adjacent states:* in Contributions to geology, Texas Univ. Publ. 4401, p. 77-208, 214 text fig., pl. 14.

NEWELL, N. D., 1935, *Some mid-Pennsylvanian invertebrates from Kansas and Oklahoma: pt. 2, Stromatoporoidea, Anthozoa, and Gastropoda:* Jour. Paleontology, v. 9, p. 341-355, pl. 33-36.

OAKES, M. C., 1940, *Geology and mineral resources of Washington County, Oklahoma:* Oklahoma Geol. Survey, Bull. 62, 208 p.

OWEN, D. D., 1852, *Report of a geological survey of Wisconsin, Iowa, and Minnesota and incidentally of a portion of Nebraska Territory:* Philadelphia, 638 p., 27 pl., maps and cross sections.

Ross, C. A., & Ross, J. P., 1962, *Pennsylvanian, Permian rugose corals, Glass Mountains, Texas:* Jour. Paleontology, v. 36, no. 6, p. 1163-1188, 11 text fig., pl. 160-163.

Ross, J. P., & Ross, C. A., 1963, *Late Paleozoic rugose corals, Glass Mountains, Texas:* Jour. Paleontology, v. 37, no. 2, p. 409-420.

ROWETT, C. L., & SUTHERLAND, P. K., 1964, *Biostratigraphy and rugose corals of the Lower Pennsylvanian Wapanucka Formation in Oklahoma:* Oklahoma Geol. Survey, Bull. 104, 124 p.

———, & KATO, M., 1968, *The coral genus* Darwasophyllum pyzhjanov, *and a related coral from S. W. Japan:* Hokkaido Univ., Jour. Fac. Sci., ser. 4, v. 14, p. 37-43, pl. 10.

ROWLEY, R. R., 1901, *Two new genera and some new species of fossils from the Upper Paleozoic rocks of Missouri:* Am. Geologist, v. 27, p. 343-355.

SMITH, STANLEY, 1913, *On the genus* Aulophyllum: Geol. Soc. London, Quart. Jour., v. 69, p. 51-77, pl. 5-9.

———, & RYDER, T. A., 1926, *The genus* Corwenia, *gen. nov.:* Ann. Mag. Nat. History (9), xvii, p. 149-159, pl. 5-6.

STEWART, E. M., 1961, *Upper Pennsylvanian rugose corals from the Possum Kingdom area of Palo Pinto County, Texas:* Unpub. master's thesis, Texas Christian Univ., 69 p.

STRIMPLE, H. L., & COCKE, J. M., 1969, *Facies and faunal relations in Pennsylvanian Missourian rocks along Oklahoma-Kansas boundary:* Am. Assoc. Petroleum Geologists (abst.). [Reprinted in Oklahoma Geol. Notes, v. 29, no. 3, p. 84.]

STUCKENBERG, A., 1904, *Anthozoen und Bryozoen des unteren Kohlenkalkes von Central-Russland:* Comité Géol., Mém., new sér., v. 14, 109 p., 9 pl.

SUTHERLAND, P. K., 1958, *Carboniferous stratigraphy and rugose coral fauna of northeastern British Columbia:* Geol. Survey Canada, Mem. 295, 177 p., 33 pl.

THOMPSON, M. L., 1957, *Northern Midcontinent Missourian fusulinids:* Jour. Paleontology, v. 31, no. 2, p. 289-328.

THOMSON, J., 1880, *Contributions to our knowledge of rugose corals from the Carboniferous limestone of Scotland:* Philos. Soc. Glasgow, Proc., v. 12, p. 225-261.

———, & NICHOLSON, H. A., 1876, *Contributions to the study of the chief generic types of the Paleozoic corals:* Annals Mag. Nat. History, ser. 4, v. 17, p. 60-70, 123-238, 290-305, 451-462; v. 18, p. 68-72, pl. 6-8, 12, 14-17, 21-25.

TISCHLER, H., 1963, *Fossils, faunal zonation and depositional environment of the Madera Formation, Huerfana Park, Calif.:* Jour. Paleontology, v. 37, no. 5, p. 1054-1068, 6 text fig., pl. 139-142.

TRAUTSCHOLD, H. A., 1879, *Die Kalkbrüche von Mjatschkowa, eine Monographie des oberen Bergkalks:* Soc. Impér. des Nat. Moscou, Mém., v. 14, 82 p., 7 pl.

WADDELL, D. E., 1966, *Ardmore Basin fusulinids:* Oklahoma Geol. Survey, Bull. 113, 128 p.

WANG, H. C., 1950, *A revision of the Zoantharia Rugosa in the light of their minute skeletal structures:* Royal Soc. London, Philos. Trans., v. 234B, no. 611, p. 175-246, pl. 4-9.

WELLER, STUART, 1898, *A bibliographic index of North American Carboniferous invertebrates:* U.S. Geol. Survey, Bull. 153, p. 161.

WHITE, C. A., 1884, *The fossils of the Indiana rocks, no. 3:* Indiana Dept. Geol. Nat. History, Ann. Rept. 13 (1883), pt. 2, p. 107-180.

———, & ST. JOHN, O. H., 1867, *Description of new sub-Carboniferous and Coal Measures fossils collected upon the geological survey of Iowa; together with a notice of new generic characters observed in two species of brachiopods:* Chicago Acad. Sci., Trans., v. 1, p. 115-127.

WILSON, E. C., & LANGENHEIM, R. L., 1962, *Rugose and tabulate corals from Permian rocks in the Ely Quadrangle, White Pine County, Nevada:* Jour. Paleontology, v. 36, p. 495-520, pl. 86-89.

WORTHEN, A. H., 1875, *Coal Measures:* Illinois Geol. Survey, v. 6, 8 p.

YABE, H., 1950, *Permian corals resembling* Waagenophyllum *and* Corwenia: Japan Acad., Proc., v. 26, no. 3, p. 74-79.

———, & SUGIYAMA, T., 1942, Akiyosiphyllum, *a new type of Permian rugose coral from Japan:* Imper. Acad., Proc., Tokyo, v. 18, p. 574-578.

ZELLER, D. E., *et al,* 1968, *The stratigraphic succession in Kansas:* Kansas Geol. Survey, Bull. 189, 81 p.,, 13 fig., 1 pl.

APPENDIX—SELECTED LOCALITIES

HERTHA FORMATION

LOCALITY H1

SE SE SE sec. 30, T. 22 S., R. 24 E., Linn County, Kansas. In ditch on west side of Kansas Highway 7. Approximately 3 miles south of Mound City, Kansas. Seven and one-half feet of undifferentiated Hertha Limestone is present, consisting of a lower limestone, a thin calcareous shale, and upper limestone. The lower 1.5 to 2 feet is a dense nonalgal calcilutite in which the brachiopod *Composita* sp. is abundant. No corals have been collected from this unit. The intervening shale, less than 1 inch thick, is poorly fossiliferous with only fragments of *Syringopora* sp. abundant. The upper 5 to 6 feet is an algal-rich calcilutite containing abundant *Caninia linnensis* COCKE, n. sp., *Neokoninckophyllum perplexum* COCKE, n. sp., *N. acolumnatum* COCKE, n. sp., *N.* sp. A, and *Dibunophyllum bourbonense* COCKE, n. sp. Most are distributed sporadically throughout the algal limestone. The accompanying fauna includes large colonies of *Syringopora* sp., *Lophamplexus westi, Antiquatonia* sp., *Hystriculina?* sp., and *Composita* sp. Numerous fenestrate bryozoans also are present.

LOCALITY H2

Near center, sec. 34, T. 25 S., R. 22 E., Bourbon County, Kansas. Roadcut on both sides of Kansas Highway 3 approximately 1.5 miles south of Uniontown, Kansas. Approximately 23 feet of undifferentiated Hertha Limestone is exposed. One to 3 feet of calcarenite underlies 20 feet of sparry algal calcilutite. In the middle part of the sparry algal calcilutite, elongated individuals of *Geyerophyllum jewetti* COCKE, n. sp., with long corallites of *Syringopora* sp. form small but striking hummocks. Few other invertebrates occur in the algal-bearing limestone. Two feet of shale and calcilutite overlie the thick algal-rich limestone.

LOCALITY H3

SW SW sec. 28, T. 22 S., R. 24 E., Linn County, Kansas. On both sides of a north-south county road. Flaring individuals of *Geyerophyllum jewetti* COCKE, n. sp. occur abundantly in 3 to 4 feet of poorly exposed sparry algal calcilutite with *Dibunophyllum bourbonense* COCKE, n. sp., *Neokoninckophyllum tushanense* (CHI, 1931) and *Caninia linnensis* COCKE, n. sp. This rock is at or near the top of the Hertha algal mound complex.

LOCALITY H7

SW SW sec. 36, T. 23 S., R. 22 E., Bourbon County, Kansas. In a small inactive quarry on the north side of Kansas State Highway 65, 2 miles east of Xenia, Kansas. Approximately 10 feet of undifferentiated Hertha algal calcilutite and sparry algal calcilutite is exposed. Collecting is excellent on float on quarry

floor. Dissepimental corals include ***Caninia linnensis*** Cocke, n. sp., *Neokoninckophyllum perplexum* Cocke, n. sp., *N. tushanense, Dibunophyllum bourbonense* Cocke, n. sp., and *Geyerophyllum jewetti* Cocke, n. sp.

LOCALITY H8

SE SE sec. 3, T. 25 S., R. 22 E., Bourbon County, Kansas. On winding north-south road approximately 3 miles north of Uniontown, Kansas.

Approximately 8.5 feet of undifferentiated Hertha Limestone is exposed here and is underlain by 3 feet of fossiliferous shale. Three subdivisions are recognized: 1) lower 4 to 6 inches of fossiliferous calcarenite, 2) calcareous shale less than 1 inch thick, and 3) upper 8 feet of massive sparry algal calcilutite. A few *Dibunophyllum bourbonense* Cocke, n. sp. and *Lophamplexus* sp. have been collected from unit 2. Accompanying fauna is rare, consisting largely of crinoid and fenestrate bryozoan fragments. A single specimen of *Geyerophyllum jewetti* Cocke, n. sp. was collected from near the middle of the sparry algal calcilutite.

LOCALITY H9

SW sec. 28, T. 21 S., R. 24 E., Linn County, Kansas. On north side of winding east-west road 4 miles west of Pleasanton, Kansas.

The upper part of the Pleasanton Group, Hertha Limestone Formation, Ladore Shale Formation, and Swope Limestone are exposed. Dissepimental corals occur in the Sniabar Limestone (Hertha Formation), and Bethany Falls Limestone (Swope Formation).

The lower Hertha Member, the Critzer, 8.5 feet thick, consists of poorly fossiliferous calcilutite to fine calcilutite. The Mound City Shale is 1.5 feet thick, calcareous with a 2-inch asphaltic calcarenite with phosphate nodules. The Sniabar Limestone is a 4.2-feet thick single bed of dense calcilutite capped by 0.8 foot of coated-grain calcarenite. It is poorly fossiliferous except a narrow zone approximately 1 foot from the base. Here, an unidentifiable ?dibunophyllid specimen occurs with *Antiquatonia* sp., *Hystriculina* sp., *Composita* sp., bryozoans and crinoid stems. The overlying Ladore Shale, approximately 11 feet thick, is badly covered by float from the Swope Formation.

The three members of the Swope are present. The lower one, the Middle Creek Limestone, is a 3.5-feet thick burrowed calcilutite which is poorly fossiliferous. The Hushpuckney Shale, 2.5 feet exposed, contains several inches of fissile black shale. The Bethany Falls is 10 feet thick and contains *Neokoninckophyllum tushanense* in the lower 2 feet. Accompanying fauna includes fenestrate bryozoans, *Composita* sp., *Neospirifer* sp., *Punctospirifer* sp., and abundant crinoid stems.

LOCALITY H10

Within city limits of Missouri City, Clay County, Missouri. Approximately 0.5 mile west of downtown area in roadcut on north side of Missouri State Highway 210.

A few feet of Hertha is exposed. *Dibunophyllum* sp. cf. *D. bourbonense* Cocke, n. sp. and an unidentified geyerophyllid have been collected in the cobbly marly calcilutite near the top of the Hertha Formation.

SWOPE FORMATION

LOCALITY BF1

SE NE NW sec. 2, T. 21 S., R. 23 E., Linn County, Kansas. Collections are from roadcut on west side of Kansas Highway 7 approximately 7 to 8 miles northwest of Mound City, Kansas. Both Hertha and Swope Limestones are well exposed at this locality. Because no dissepimental corals have been recovered from the former, it will not be discussed here. The two lower members of the Swope Formation, the Middle Creek Limestone and Hushpuckney Shale, are identified and the boundary between the underlying Ladore Shale and the Bethany Falls Limestone is gradational. The Hushpuckney Shale slope is covered by large numbers of *Hystriculina* sp., *Rhipidomella* sp., chonetids, crinoid fragments, and rugose corals. These are found ***in situ*** in 1 foot of nodular limestone and interbedded shale below the massive Bethany Falls Limestone. Corals include *Lophophyllidium* sp., *Dibunophyllum hystricosum* Cocke, n. sp., and *Neokoninckophyllum tushanense*. The latter species is found rarely in the lower part of the Bethany Falls massive beds.

LOCALITY BF2

SW SW SW sec. 31, T. 19 S., R. 25 E., Linn County, Kansas. Section at the intersection of Kansas Highway 135 and old U.S. Highway 69 approximately 3 miles east of La Cygne, Kansas. Approximately 11 feet of fossiliferous calcilutite of the Bethany Falls Limestone is exposed. It is capped by 3 feet of unfossiliferous oolite. A single crushed unidentifiable geyerophyllid has been collected from the lower 4 feet of exposed rock. Accompanying fauna includes *Stereostylus* sp., fenestrate bryozoans, and crinoid stems.

LOCALITY BF4

Middle of south line, sec. 18, T. 20 S., R. 24 E., Linn County, Kansas. Approximately 1.5 miles west and 2.5 miles south of La Cygne, Kansas. *Neokoninckophyllum tushanense* and *N. acolumnatum* Cocke, n. sp. have been collected from Swope float in a north-south road ditch.

LOCALITY BF5

SE SE SE sec. 25, T. 23 S., R. 24 E., Linn County, Kansas. On a north-south county road approximately 3 miles southwest of Mound City, Kansas. Three limestone units are readily recognized. 1) A cobbly 5-feet poorly fossiliferous thick limestone (=Hertha?) is present at the base of the section and is overlain by 7 feet of Ladore Shale. 2) The Middle Creek Limestone of the Swope which is 15 feet thick and forms a ledge near the center of the section. It contains rare brachiopods and crinoid fragments. It is overlain by 5 feet of Hushpuckney Shale which contains abundant individuals of *Derbyia* sp. Several inches of fissile black shale occurs near its top. 3) The uppermost Bethany Falls Limestone is 5 feet thick. The lower 1 foot contains fenestrate bryozoans, *Composita* sp., and *Neospirifer* sp. brachiopods, and *Neokoninckophyllum tushanense*. The overlying 4.5 feet contains rare phylloid algae, abundant fenestrate bryozoans, *Linoproductus* sp., and *Antiquatonia* sp.

LOCALITY BF6

(Gravel pile) NW NW NW sec. 1, T. 23 S., R. 23 E., Linn County, Kansas, 4 miles south and 1 mile west of Mound City, Kansas. *Dibunophyllum hystricosum* Cocke, n. sp., *Neokoninckophyllum tushanense,* and *N. acolumnatum* Cocke, n. sp. are present at the top of the Bethany Falls Limestone or at the base of the Galesburg Shale. The corals occur together with abundant fenestrate bryozoans, chonetids, *Hystriculina* sp., and crinoid stems. Note: the condition of the outcrop suggests that the fossiliferous shale has been moved in.

LOCALITY BF7

NW corner, sec. 30, T. 29 S., R. 20 E., Neosho County, Kansas. On roadcut of U.S. Highway 59, 5 miles south of Erie, Kansas.

The Swope is approximately 4.5 feet thick. The basal 1.5 feet of limestone is argillaceous. Algal calcilutite covers the argillaceous limestone. On a bedding 2 feet from the base of the algal calcilutite, one specimen of *Geyerophyllum patulum* Cocke, n. sp., several individuals of *Neokoninckophyllum tushanense,* and a single unidentifiable dibunophyllid have been collected. None were in growth position. Accompanying fauna includes *Stereostylus* sp., ramose bryozoans, *Antiquatonia* sp., *Composita* sp., and abundant crinoid stems.

LOCALITY BF8

NE corner of sec. 25, T. 22 S., R. 24 E., Linn County, Kansas. In roadcut of U.S. Highway 169 and east-west county road. Four units are recognizable in the Swope Formation: 1) a lower 1.5 feet of poorly fossiliferous marly calcilutite (Middle Creek Member), 2) 5 feet of Hushpuckney Shale which contains a 1.2-feet black shale in the lower half; *Derbyia* sp. brachiopods are extremely abundant above the black shale; 3) 1 to 1.5-foot thick calcilutite in the lower Bethany Falls Limestone which contains abundant *Neokoninckophyllum tushanense* as well as fenestrate bryozoans, *Composita* sp., *Neospirifer* sp., and crinoid ossicles and stems; and 4) 4.5 feet of calcilutite which contains rare ?phylloid algae, *Lophophyllidium* sp., *Linoproductus* sp., *Antiquatonia* sp., fenestrate bryozoans, and abundant crinoid parts. No dissepimental corals have been collected from the upper limestone.

DENNIS FORMATION

LOCALITY Win1

NW sec. 31, T. 19 S., R. 25 E., Linn County, Kansas, 0.2 mile south of the Linn-Miami County line; in roadcut of U.S. Highway 69, 4 miles east and 1 mile north of La Cygne, Kansas. *Neokoninckophyllum tushanense* and *N. acolumnatum* Cocke, n. sp. occur abundantly in the thin calcareous shales in the middle of the upper 12 to 14 feet of the Winterset Member of the Dennis Formation. The enclosing limestone contains abundant phylloid algae. Few of the corals are in growth position and none are noticeably abraded. Well-preserved individuals of *Lophophyllidium* sp., *Neospirifer* sp., *Antiquatonia* sp., *Linoproductus* sp., *Pulchratia* sp., *Composita* sp., and *Hustedia* sp. occur abundantly with the neokoninckophyllids. The lower 15 feet which includes calcareous shale, oolitic calcareous shale, and mottled calcilutite has no rugose corals.

LOCALITY Win2

NW NE sec. 16, T. 26 S., R. 20 E., Allen County, Kansas. Poor exposure in gully on north side of east-west county road. Five feet of algal calcilutite and skeletal calcarenite of the Winterset Member is exposed. *Dibunophyllum hystricosum* Cocke, n. sp. is abundant locally on the uppermost exposed surface.

LOCALITY Win3

SE SW sec. 28, T. 18 S., R. 25 E., southeastern Miami County, Kansas. In a quarry north of east-west county road. Approximately 32 feet of the Winterset Limestone Member (Dennis Formation) is exposed. *Dibunophyllum hystricosum* Cocke, n. sp., *Neokoninckophyllum tushanense,* and *N. acolumnatum* Cocke, n. sp. occur sporadically along calcareous shale interbeds and thin calcareous stringers in the lower 24 feet. None are apparently in growth position. Generally present with the neokoninckophyllids are well-preserved *Neospirifer* sp., *Composita* sp., *Antiquatonia* sp., *Pulchratia* sp., *Juresania* sp., and *Linoproductus* sp.

LOCALITY Win8

SE sec. 20, T. 28 S., R. 19 E., Neosho County, Kansas. In inactive quarry approximately 6.5 miles west of Erie, Kansas.

Fifty feet of the Winterset Member is exposed. The lower 43 feet of calcilutite contains no dissepimental corals. However, *Neokoninckophyllum tushanense* and *N. acolumnatum* Cocke, n. sp. are found in the upper 7 feet of well-bedded algal calcilutite. Most were collected from the top of the limestone beds or in thin calcareous shale interbeds. Accompanying invertebrates are abundant and include large well-preserved *Composita* sp., *Antiquatonia* sp., *Linoproductus* sp., fenestrate bryozoans, and crinoid stems.

CHERRYVALE FORMATION

LOCALITY Wes1

Near center sec. 27, T. 11 S., R. 24 E., Wyandotte County, Kansas. Measured 100 yards north of entrance to Inland Underground Storage along bluffs of Kansas River. Approximately 4.5 miles northeast of Holliday, Kansas. The Swope, Dennis, and Iola are well exposed along the river bluffs. Only the Westerville Member of the Cherryvale Formation contains dissepimental corals. (See Loc. Drl for discussion of the Cement City locality.)

The Westerville Limestone consists of two parts: 1) a lower 10.5-feet thick sequence of interbedded limestones and shales, and 2) upper 4 feet of oolitic to skeletal calcarenite. The lower unit is largely composed of sparry algal calcilutite and calcareous shales. *Neokoninckophyllum kansasense* var. 1 is abundant and *N. kansasense* var. 2 is represented by lesser numbers. A few transitional forms are present. Few are entirely surrounded by limestone matrix but have calices which extend into the calcareous shale. Most specimens have been collected from the calcareous shale. The prolific accompanying fauna includes very numerous *Stereostylus* sp., fenestrate and ramose bryozoans, large *Composita,* sp., *Neospirifer* sp., *Punctospirifer* sp., *Hustedia* sp., *Phricodothyris* sp., *Antiquatonia* sp., chonetids, crinoid fragments, and gastropods. Most show little evidence of abrasion.

The upper calcarenite is a fossiliferous cross-bedded oolite in the lower 3.5 feet; the upper 0.5 foot is a skeletal calcarenite. No dissepimental corals are present in either unit.

LOCALITY Wes2

Center of the east line, sec. 25, T. 49 N., R. 32 W., Jackson County, Missouri. On U.S. Highway 435, 1 mile south of the intersection of U.S. 70. In Kansas City, Missouri.

Approximately 20 feet of Westerville Limestone is exposed here. In general the section is similar to that of Wes3. The upper surface of the calcarenite is undulatory. Thousands of specimens of *Neokoninckophyllum kansasense* are present, of which *N. kansasense* var. 2 is more numerous. Few other fossils are present and specimens of *N. kansasense* encrust other individuals of the species or several may cluster on a common surface. Many widely flaring forms typically have no attachment area and presumably rested in the mud bottom.

LOCALITY Wes3

NW SE sec. 6, T. 48 N., R. 32 W., Jackson County, Missouri.

Active McClain quarry off James A. Reed Road in Kansas City, Missouri.

The Westerville Limestone Member consists of 20 feet of cross-bedded osagitic to oolitic calcarenite which is richly fossiliferous particularly in fenestrate bryozoans, myalinid bivalves, gastropods, and lesser numbers of *Antiquatonia* sp., *Juresania* sp., and *Composita* sp. brachiopods. A few specimens of *Neokoninckophyllum kansasense* var. 1 and var. 2 are found in a 6-inch shale at 7.5 feet from the top and at the contact between the highest beds of the Westerville and green calcareous shale of the Quivira Member.

Three feet of the Cement City is present here from which *Caninia torquia, Dibunophyllum clathrum* Cocke, n. sp., and *Geyerophyllum girtyi* Cocke, n. sp., have been collected.

LOCALITY Bk1

Center north line, sec. 31, T. 18 S., R. 25 E., Miami County, Kansas. In roadcuts of U.S. Highway 169 and intersecting east-west county road.

Approximately 4 feet of badly weathered well-bedded nonalgal calcilutite is present. Invertebrates are sparse but include lophophyllid corals, fenestrate bryozoans, *Composita* sp., *Antiquatonia* sp., and crinoid stems. Relatively rare *Neokoninckophyllum petilum* Cocke, n. sp., and *Geyerophyllum patulum* Cocke, n. sp., are enclosed in the calcilutite matrix.

DRUM FORMATION

LOCALITY Dr1

Composite section, sec. 23 and 27, T. 11 S., R. 24 E., Wyandotte County, Kansas City, Kansas. Section is along Kansas River bluffs approximately 2 miles northeast of Turner, Kansas. Approximately 5 feet of laminated to fossiliferous calcilutite of the Cement City Member is present, overlain locally by a few inches of skeletal calcarenite. Shale seams contain the corals *Lophophyllidium* sp., *Dibunophyllum clathrum* Cocke, n. sp., and *Geyerophyllum girtyi* Cocke, n. sp. *Caninia torquia* occurs only in the upper shale and calcarenite.

LOCALITY Dr2

S½, sec. 12, T. 11 S., R. 24 E., Wyandotte County, Kansas. In the roadcut on north side of Kansas Highway 32. Total Cement City Limestone is 9.5 feet. The rock is poorly fossiliferous calcilutite in which fossils are concentrated along thin shale beds or bedding surfaces. Fossils include numerous *Syringopora* sp., *Stereostylus* sp., fenestrate bryozoans, *Composita* sp., *Punctospirifer* sp., *Teguliferina* sp., *Hystriculina* sp., crinoid cups and stems, and rare trilobite fragments. Included in the shale beds and bedding surfaces but largely concentrated on the upper surfaces of the member are *Dibunophyllum clathrum* Cocke, n. sp., *Caninia torquia,* and *Geyerophyllum girtyi* Cocke, n. sp.

IOLA FORMATION

LOCALITY I2

SW SW SW sec. 33, T. 19 S., R. 22 E., Linn County, Kansas. In road ditch north side of east-west county road, about 25 yards east of small bridge.

Approximately 5 feet of the lower Iola Formation is poorly exposed over sandstone and siltstone of the Chanute Formation. Neither Paola Limestone Member or Muncie Creek Shale Member can be identified. The Iola here is an invertebrate-calcilutite in which abundant *Dibunophyllum elegente* Cocke, n. sp., occur with fenestrate bryozoans, *Composita* sp., and gastropods in the upper 3 feet.

WYANDOTTE FORMATION

LOCALITY Wy1

NW NE sec. 28, T. 12 S., R. 22 E., DeSoto, Johnson County, Kansas. In a small quarry in DeSoto, Kansas. Approximately 15.5 feet of Farley Limestone Member of the Wyandotte Formation, 1 foot of Bonner Springs Shale Formation and 12.5 feet of the Plattsburg Limestone Formation are exposed in the quarry.

The lower 14 feet of the Farley consists of invertebrate-rich algal calcilutite and thin calcareous shales. *Geyerophyllum* sp. cf., *G. broilii* and *Dibunophyllum parvum* are distributed unevenly throughout the algal limestone and calcareous shales. In the upper 3 feet of this sequence, *Neokoninckophyllum variabile* Cocke, n. sp., occurs abundantly in growth position along bedding surfaces. A 1.5-feet skeletal calcarenite which is barren of dissepimental corals caps the Farley Limestone. The 1-foot thick Bonner Springs Shale Formation contains sparse fragments of brachiopods and bryozoans.

The Plattsburg Formation consists of 1) the Merriam Limestone which is 4 feet thick and contains large numbers of *Composita* sp. and appears to be extensively burrowed, 2) 1.5 feet of poorly fossiliferous Hickory Creek Shale, and 3) the Spring Hill Limestone which is 7.0 feet thick. *Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum sp. cf. G. broilii* occur sporadically with abundant lophophyllid corals, bryozoans, and brachiopods.

LOCALITY Wy2

NW NW sec. 1, T. 13 S., R. 22 E., Johnson County, Kansas. In a small abandoned quarry on south side of east-west county road 4 miles south and 1.5 miles east of DeSoto, Kansas.

The Wyandotte Formation is represented by 15.5 feet of beds with well-developed Argentine and Farley Limestones. The lower 10 feet is the Argentine Member. It is largely a well-bedded nonalgal calcilutite containing large numbers of crinoid fragments, bryozoans, and brachiopods. Dissepimental corals are represented by rare specimens of *Dibunophyllum parvum* and *Geyerophyllum* sp. cf. *G. broilii.* The intervening Island Creek Shale is 1.0 foot thick.

Only 4.5 feet of the well-bedded lower Farley Limestone is exposed. Rock types range from invertebrate-rich calcilutite to algal calcilutite in major beds to skims of skeletal calcarenite at the top of the calcilutite beds. *Neokoninckophyllum variabile* Cocke, n. sp., *Dibunophyllum parvum,* and *Geyerophyllum* sp. cf. *G. broilii* occur throughout the unit but are more common in the thin calcarenites.

LOCALITY Wy3

SE SE SW sec. 25, T. 12 S., R. 23 E., Johnson County, Kansas. On east-west county road approximately 2 miles east of intersection of Kansas Highway 7 and Kansas Highway 10. Section is well exposed along county road and large active quarry north of the road. In addition to the entire Lansing Group, the Chanute, Iola, and Lane Formations of the Kansas City Group are present here. However, none will be discussed because they do not contain dissepimental corals.

The upper member of the Kansas City Group, the Wyandotte Formation, consists of five members. The lower two members, the Frisbie Limestone and Quindaro Shale which are 5 feet and 3.5

feet thick, respectively, contain no dissepimental corals. The Argentine Limestone consists of 12 feet, of which the lower 10.5 feet is largely algal calcilutite to sparry algal calcilutite and thin calcareous shale. Approximately 300 specimens of *Dibunophyllum parvum* have been collected from a single hummock 150 yards north in the lower Argentine. Many are in growth position and a wide range of sizes exists here. In addition, large numbers of other invertebrates are present including one specimen of *Geyerophyllum* sp. cf. *G. broilii*. *D. parvum* and *G.* sp. cf. *G. broilii* occur sporadically throughout the algal-rich rock. The upper 2 feet of Argentine Limestone consists of crinoidal to bryozoan calcarenite with abundant molluscans, including *Aviculopecten* sp.

The Island Creek Shale Member of the Wyandotte is 8 feet thick and contains ramose bryozoans, *Composita* sp., molluscan debris, and crinoid fragments in the upper 2 feet.

The Farley Limestone, 22 feet thick, largely consists of algal-rich calcilutite interspersed with thin calcareous shales, silty shales, and skeletal calcarenite. Numerous well-preserved *Neokoninckophyllum variabile* Cocke, n. sp., have been collected in the algal limestones and calcareous shales. No dibunophyllids were found at this locality. Bryozoans, *Composita* sp., *Neospirifer* sp., *Antiquatonia* sp., and gastropods are particularly abundant in the calcareous shales. Conicocylindrical, seemingly fasciculate *G.* sp. cf. *G. broilii* with a spinose columella occur in great profusion in the skeletal calcarenite near the top of the member.

The overlying Bonner Springs Shale and Plattsburg Limestone contain no dissepimental corals.

LOCALITY Wy5

Near center south line, sec. 23, T. 12 S., R. 23 E., Johnson County, Kansas. In a small abandoned quarry 1.5 miles northeast of DeSoto, Kansas. Less than 10 feet of the Farley Member (Wyandotte Formation) is exposed. *Dibunophyllum parvum* and *Geyerophyllum* sp. cf. *G. broilii* occur abundantly in thin calcareous shale beds. Most corals were collected from float boulders on the quarry floor.

LOCALITY Wy7

SE sec. 12, T. 11 S., R. 24 E., Wyandotte County, Kansas. On north side of Kansas Turnpike 70 in Kansas City, Kansas.

Only the Argentine Member (Wyandotte Formation) is present at the locality. The underlying Lane Shale is poorly exposed southward toward Kansas Highway 32. The Frisbie Limestone, Quindaro Shale, Argentine Members of the Wyandotte Formation, are present on the south side of the Kansas Turnpike. The Frisbie Limestone, 2.5 feet thick, and Quindaro Shale, 2.0 feet thick, contain no dissepimental corals.

The exposed Argentine Limestone is 14.0 feet thick, well-bedded, and consists of invertebrate-rich calcilutite with lesser amounts of algal calcilutite. *Dibunophyllum parvum* and *Neokoninckophyllum variabile* Cocke, n. sp., are present within both limestone types but are particularly abundant along calcareous shale beds or stylolitic seams.

LOCALITY Wy8

SE SE SE sec. 8, T. 17 S., R. 21 E., Franklin County, Kansas. Roadcut in county road. Undifferentiated Wyandotte beds 23 feet thick are exposed.

Two units are recognized: 1) lower 20.5 feet of algal-rich calcilutite, and 2) upper 2.5 feet of skeletal calcarenite. The lower unit contains relatively abundant *Geyerophyllum* sp. cf. *G. broilii* and *Neokoninckophyllum variabile* Cocke, n. sp., but relatively few *Dibunophyllum parvum*. The accompanying fauna commonly contains *Lophophyllidium* sp., fenestrate bryozoans, *Enteletes* sp., *Echinoconchus* sp., *Antiquatonia* sp., and crinoid fragments.

The upper 2.5 feet contain no dissepimental corals and only rare fusulinids, bryozoans, and other skeletal material.

LOCALITY Wy9

NE NE sec. 32, T. 13 S., R. 23 E., Johnson County, Kansas. In Olathe Lake spillway. Approximately 2 miles west of Olathe, Kansas. Wyandotte Limestone 64 feet thick is well exposed here.

The Frisbie Limestone is slightly less than 2 feet thick and largely consists of calcilutite containing organic fragments coated by stromatolites. Also present are fenestrate bryozoan fragments, *Composita* sp. and unidentified gastropods. The Quindaro Shale is a 2-inch thick calcareous shale containing fragmented skeletal material. No dissepimental corals have been collected from the lower two members of the Wyandotte.

The Argentine Limestone is 35.5 feet thick and consists of a lower 29.5-feet algal-rich calcilutite to algal calcarenite and an upper 6 feet of poorly fossiliferous calcilutite and crinoidal calcarenite. A few specimens of *Neokoninckophyllum variabile* Cocke, n. sp., *Dibunophyllum parvum*, and *Geyerophyllum* sp. cf. *G. broilii* have been collected along bedding surfaces and are accompanied by *Punctospirifer* sp., *Composita* sp., and crinoid fragments. Corals were not found in the upper 6 feet of Argentine Limestone. The Island Creek Shale is fossiliferous, containing abundant fusulinids, fenestrate bryozoans, and small brachiopods.

The Farley Limestone, 25.5 feet thick consists of a lower 18.5 feet of algal-rich calcilutite and an upper 7.0 feet of oolitic calcarenite and algal calcarenite. Phylloid algae, fusulinids, *Lophophyllidium* sp., fenestrate bryozoans, *Composita* sp., *Juresania* sp., *Echinoconchus* sp., *Antiquatonia* sp., and crinoid fragments are particularly common in the lower 4.5 feet of the lower unit. *Neokoninckophyllum variabile* and *Geyerophyllum* sp. cf. *G. broilii* occur sporadically throughout the next 14 feet of algal calcilutites and calcarenites with abundant *Composita* sp. and fenestrate bryozoans. Corals have not been collected from the 7.0 feet of oolites and organic calcarenite which caps the Farley Limestone.

LOCALITY Wy10

SW SW sec. 29, T. 13 S., R. 23 E., Johnson County, Kansas. In quarry north of east-west county road, 2.5 miles west of Olathe, Kansas.

The upper three members of the Wyandotte Formation, the Bonner Springs Formation, and the Merriam Limestone Member of the Plattsburg Limestone are present. The Wyandotte Argentine Limestone consists of 1) wavy bedded 13 feet of algal-rich calcilutite and a few thin calcareous shale, 2) 5 feet of osagitic skeletal calcarenite containing ramose and fenestrate bryozoans, crinoid fragments, and the large clam *Aviculopecten* sp. *Neokoninckophyllum variabile* and *Geyerophyllum* sp. cf. *G. broilii* occur rarely in the algal calcilutite. The Island Creek, 1.5 feet thick, is a poorly fossiliferous calcareous shale which contains no rugose corals.

The Farley Limestone Member (Wyandotte Formation), consists of 27 feet of invertebrate-rich calcilutite, algal calcilutite, and thin calcareous shales. Specimens of *Geyerophyllum* sp. cf. *G. broilii* have been collected from the lower 5.5 feet of algal calcilutite. They are particularly abundant within thin shales and stylolitic seams. *Antiquatonia* sp., abundant crinoid stems, and *Composita* sp., accompany the geyerophyllids.

The Bonner Springs Shale Formation is 19 feet thick and the Merriam Limestone (Plattsburg Formation) is 5 feet thick. Neither contains dissepimental corals.

LOCALITY Wy11

SE NW sec. 9, T. 13 S., R. 22 E., Johnson County, Kansas. On east wall of inactive Sunflower Munitions Quarry, south side of east-west county road, approximately 2.5 miles south of DeSoto, Kansas.

The Wyandotte Formation is represented by the upper 37.5 feet of Argentine Limestone, 1.2 feet of Island Creek Shale, and 14.5 feet of Farley Limestone. In addition, 30 feet of Bonner Springs Shale is exposed, capped by 7 feet of lower Plattsburg Limestone. Dissepimental corals have been collected from the lower Farley Limestone only.

The lower 10 feet of Farley contains small numbers of *Neokoninckophyllum variabile* Cocke, n. sp., *Dibunophyllum parvum*, and *Geyerophyllum* sp. cf. *G. broilii* within an invertebrate algal-rich calcilutite. Other abundant fossils include fenestrate bryozoans, crinoid fragments, and the brachiopods *Composita* sp., *Enteletes* sp., and *Antiquatonia* sp.

LOCALITY Wy12

SW SW sec. 31, T. 14 S., R. 14 E., Johnson County, Kansas. In an active quarry, 0.3 mile west of U.S. Highway 69, north of east-west county road. Section modified from one measured by D. J. Crowley (1966, p. 171-172). The lower two members of the Wyandotte are not definitely recognized here. Total Wyandotte exposed is 55 feet.

Approximately 30 feet of Argentine Limestone is exposed in a quarry and small creek bed west of the quarry. The rock is largely algal calcilutite. Phylloid algae increase in abundance upward. A few specimens of *Dibunophyllum parvum* and *Geyerophyllum* sp. cf. *G. broilii* have been collected in the upper 10 feet, accompanied by fenestrate bryozoans, *Composita* sp., *Punctospirifer* sp., *Hustedia* sp., and echinoderm fragments.

The Island Creek is a 0.5-foot thick calcareous shale in which fusulinids, fenestrate and ramose bryozoans, *Punctospirifer* sp., echinoid spines, and crinoid fragments are common. No dissepimental corals are present.

Three lithic units can be recognized in the Farley Limestone. 1) A lower unit is a 25-feet calcilutite containing abundant phylloid algae. Fusulinids, fenestrate bryozoans, and productids are extremely common in the lower 0.5 foot. Within the algal-rich calcilutite, *Neokoninckophyllum variabile* and *Geyerophyllum* sp. cf. *G. broilii* are sparse. Fenestrate bryozoans, *Composita* sp., *Hustedia* sp., *Antiquatonia* sp., and crinoid fragments are common. The upper 1 to 1.5 feet consists of algal to skeletal calcarenite in which no dissepimental corals are found. 2) The middle unit of the Farley consists of approximately 2.5 feet of silty unfossiliferous shale. 3) The upper unit is a 6-feet thick calcarenite, the lower 1.5 feet composed of coated skeletal calcarenite with *Myalina* sp. and crinoid fragments particularly abundant. The overlying 4.5 feet of algal calcarenite is rich in the alga *Archaeolithophyllum* sp., fenestrate bryozoans, *Composita* sp., and crinoid fragments. No dissepimental corals have been collected from the upper two units of the Farley Limestone. Several feet of Bonner Springs Shale Formation overlies the Wyandotte Limestone.

PLATTSBURG FORMATION

LOCALITY Pb1

NW SE sec. 34, T. 20 S., R. 19 E., Anderson County, Kansas. In abandoned quarry one-eighth mile south of FAS 10, approximately 2.5 miles southwest of Garnett, Kansas.

About 32 feet of the upper Spring Hill Member (Plattsburg Formation) is exposed here. The lower 6 feet consists of dense nonalgal calcilutite interspersed with thin skims of fusulinid-rich calcarenite which contain few specimens of *Neokoninckophyllum variabile, Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum* sp. cf. *G. broilii*. Commonly the accompanying fauna is dominated by large fusulinids and echinoid spines, *Antiquatonia* sp., *Hystriculina* sp., *Composita* sp. and fenestrate bryozoans. All faunal elements are most numerous in depressions along bedding planes. The overlying 18 feet of calcilutite shows marked increase in phylloid algal content upward and a general decrease in fauna including dissepimental corals. Overlying the algal calcilutite is 6.5 feet of skeletal calcilutite consisting largely of fusulinids, fenestrate bryozoans, crinoid stems, echinoid spines, *Composita* sp., large *"Euconospira"* sp., and the nautiloid *Titanoceras* sp. Particularly spectacular are large colonies of the stromatoporoid *Parallelopora* sp. which reach 6 feet across. *Geyerophyllum* sp. cf. *G. broilii* is found throughout the calcarenite but most specimens are abraded. A few representatives of the species are on the stromatoporoid in growth position. The uppermost bed of this section is a 1.5-feet thick sparry algal calcilutite which contains no invertebrates.

LOCALITY Pb2

NW NW sec. 6, T. 20 S., R. 20 E., Anderson County, Kansas. East side of Kansas Highway 59, 4 miles north of Garnett, Kansas. The three divisions of the Plattsburg are recognized here: 1) Merriam Limestone slightly less than 3 feet thick, 2) 4-inch thick Hickory Creek Shale, 3) Spring Hill Limestone 16.5 feet thick. No dissepimental corals are present in the lower members; lophophyllids are rare in the Merriam Limestone.

Here at the northern edge of the northern Plattsburg algal-mound complex the unit is quite variable. Five subdivisions are recognized. 1) The lower 2 feet consists largely of nonalgal calcilutite with bryozoans, brachiopods, and fragmental crinoids. 2) Nonalgal calcilutite 7.5 feet thick is generally similar to the lower 2 feet except that *Neokoninckophyllum variabile, Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum* sp. cf. *G. broilii* occur sporadically along thin calcareous shales, stylolitic contacts, and thin calcarenites. The upper 2 feet has increased amounts of phylloid algae. 3) Sparry algal calcilutite occurs in a 1.2-feet bed; few invertebrate fragments and no corals are present. 4) Skeletal calcarenite 3.4-feet thick comprises the succeeding unit. Only a few specimens of *Geyerophyllum* sp. cf. *G. broilii* are present. The stromatoporoid *Parallelopora* sp. forms large masses locally. 5) Slightly more than 2 feet of sparry algal calcilutite caps the section. No invertebrates have been collected from this unit.

LOCALITY Pb3

Middle sec. 23, T. 20 S., R. 19 E., Anderson County, Kansas. In ditch on south side of Kansas State Highway 31, 2 miles northwest of Garnett, Kansas. Exposures are poor and exact stratigraphic position within the Spring Hill Member is not determinable.

A total of 18 feet of Spring Hill Limestone crops out here. The lower 10 feet is a highly fossiliferous calcilutite in which

bryozoans, brachiopods, and rare algae occur with abundant *Neokoninckophyllum variabile, Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum* sp. cf. *G. broilii.* This is overlain by a skeletal calcarenite in which numerous fusulinids and echinoid spines are present. Corals were not collected in the calcarenite. The overlying 5 feet is a calcilutite similar to that of the lower 10 feet but contains several calcarenitic limestone interbeds.

LOCALITY Pb4

SW NW sec. 27, T. 20 S., R. 19 E., Anderson County, Kansas. On north side of winding east-west county road, approximately 2.5 miles west of Garnett, Kansas. Exact stratigraphic position within the Spring Hill is not determined.

Well-bedded fossiliferous calcilutite 12.5 feet thick is exposed. A few beds contain sparse phylloid algae. Calcilutite contains abundant fusulinids, *Composita* sp., and crinoid parts, as well as *Neokoninckophyllum variabile, Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum* sp. cf. *G. broilii.* All bedding surfaces have a skim of richly fossiliferous fine calcarenite dominated by fusulinids, echinoid spines, and crinoid fragments. Brachiopods include *Composita* sp., *Hystriculina* sp., *Crurithyris* sp., and rare *Derbyia* sp. Fenestrate bryozoans are extremely rare. *N. variabile, D. parvum,* and *G.* sp. cf. *G. broilii* occur abundantly in growth position.

LOCALITY Pb5

SE NE sec. 4, T. 21 S., R. 20 E., Anderson County, Kansas. In small quarry on north side of east-west county road on east side of hill, 2 miles south and 0.5 mile east of Garnett, Kansas. Exact position in the Spring Hill Limestone is unknown.

About 15 feet of Spring Hill Limestone is poorly exposed. The limestone is a well-bedded calcilutite which contains abundant fenestrate bryozoans, *Composita* sp., and *Punctospirifer* sp. Dissepimental corals, *Neokoninckophyllum variabile, Dibunophyllum valeriae,* and *Geyerophyllum garnettense* Cocke, n. sp., occur abundantly on calcarenitic skims at the top of several calcilutite layers. They are accompanied by crinoid fragments, *Composita* sp., fenestrate bryozoans, and lophophyllid corals.

Approximately 6 feet of similar rock is exposed in a roadcut west to the top of the hill. However, no dissepimental corals have been recovered from these rocks.

LOCALITY Pb6

Sec. 18, T. 11 S., R. 23 E., Leavenworth County, Kansas. In roadcut on south side of Kansas Turnpike 70, 1.25 miles west of Bonner Springs Interchange.

The Plattsburg is 18.5 feet thick, consisting in ascending order of Merriam Limestone, 2.5 feet; Hickory Creek Shale, 1.0 feet; Spring Hill Limestone, 15 feet. Because only lophophyllid corals are present in the lower two members, they are not discussed in detail here.

The Spring Hill Limestone largely consists of invertebrate-rich calcilutite with thin calcareous shales and fine calcarenites. *Neokoninckophyllum variabile, Dibunophyllum parvum, D. valeriae,* and *Geyerophyllum* sp. cf. *G. broilii* are distributed throughout the unit but are somewhat more numerous along bedding surfaces, calcareous shale calcarenite skims, and stylolitic contacts. Accompanying fauna includes fusulinids, lophophyllid corals, fenestrate and ramose bryozoans, *Linoproductus* sp., *Composita* sp., *Neospirifer* sp., chonetids, *Enteletes* sp., several molluscan genera, crinoid fragments, and echinoid spines.

LOCALITY Pb7

NW sec. 18, T. 30 S., R. 16 E., Wilson County, Kansas. In active Carr Quarry less than 1 mile northwest of Neodesha, Kansas.

Approximately 25 feet of Plattsburg algal limestone is exposed, overlain by 3 to 4 feet of oolitic skeletal calcarenite. A thin calcilutite containing abundant fragments of the alga *Archaeolithophyllum* sp. locally caps the less algae-rich limestone. *Neokoninckophyllum variabile* and *Dibunophyllum valeriae* occur in growth position in a thin shale bed below the *Archaeolithophyllum* cap. No corals are found in the 3.5-feet thick oolitic skeletal calcarenite which is the uppermost bed of the Plattsburg Formation. Corals have not been collected in the overlying Vilas Shale and Stanton Limestone.

LOCALITY Pb8

W½, sec. 19, T. 19 S., R. 15 E., Wilson County, Kansas. In north end of active quarry in southern part of Fredonia, Kansas. Approximately 31 feet of limestone is exposed in the north end of the quarry. Most represents Stanton Limestone but the lower part probably represents transitional beds between the Plattsburg and Stanton across the Vilas Shale interval. Laterally, the section represents the transition between the Stanton algal complex at the south and a Stanton channel deposit to the north. The lower 2 feet consists of algal calcilutite to calcarenite and calcareous shale interbeds. The limestone bed contains abundant fusulines, echinoid spines, fenestrate bryozoans, *Punctospirifer* sp., *Composita* sp. and *Rhipidomella* sp. *Neokoninckophyllum variabile* and *N. acolumnatum* Cocke, n. sp., are found abundantly in growth position, particularly along upper surfaces of the calcilutite. Approximately 6 feet is covered.

Overlying the covered interval is 23 feet which has lenticular skeletal calcarenites and algal calcilutites. Algal and sponge content increases upward. No dissepimental corals have been found in this interval; however, a single unidentifiable neokoninckophyllid has been obtained from equivalent beds in the southwest corner of the quarry.

LOCALITY Pb9

SW NW sec. 32, T. 29 S., R. 15 E., Wilson County, Kansas. On northeast side of St. Louis-San Francisco railroad track along Fall River. Approximately 4 miles southeast of Fredonia, Kansas.

The Plattsburg Limestone is 38 feet thick and consists of 1) lower 25 feet of massive algal limestone which contains a few bryozoan and crinoid fragments, 2) 11 feet of crinoid-rich skeletal calcarenite which has a few *Neokoninckophyllum variabile* and *Dibunophyllum valeriae* along the upper undulating surface, and 3) 2 feet thick oolitic calcarenite containing the stromatoporoid *Parallelopora* sp., fusulines, *Aviculopecten* sp., and *Meekella* sp. The overlying Vilas consists of 6 feet of shale and thin algal calcilutites in which no dissepimental corals have been found.

LOCALITY Pb10

SW NW sec. 24, T. 31 S., R. 15 E., Montgomery County, Kansas. In active quarry north of road 1 mile west and 0.5 mile north of Sycamore, Kansas.

Total Plattsburg thickness is 82 feet. The lower 57 feet consists of interbedded sponge-rich interbeds of calcilutite and calcareous shales which contain no dissepimental corals. The upper 25 feet largely consists of algal calcilutite and a few calcareous shale interbeds. Fusulinids and crinoids become increasingly abundant in the upper 6 feet of algal rock. Specimens of *Neokoninckо-*

phylum variabile Cocke, n. sp., were found 14 feet from base of the algal rock. Crinoid stems, bryozoans, and brachiopods are moderately abundant in the calcareous shales. A single unidentifiable geyerophyllid was collected from a float boulder on the quarry floor.

LOCALITY Pb11

SW SE sec. 23, T. 30 S., R. 15 E., Wilson County, Kansas. On Kansas Highway 96, 3 miles west of Neodesha, Kansas.

Two dissepimental-bearing units are present: the Plattsburg Formation and Captain Creek Limestone Member of the Stanton Formation. The Plattsburg, 105 feet thick, is separated from the Captain Creek by a 9-feet interval of Vilas Shale Formation comprised of calcareous shale and thin algal and invertebrate-rich calcilutites. The exposed Captain Creek is approximately 10 feet thick.

The Plattsburg is composed of 1) lower interbedded calcilutites and calcareous shales which are 38 feet thick and have numerous sponges and other invertebrates, 2) 22 feet of poorly fossiliferous pelletal calcilutite, 3) algal-rich calcilutite which is 42 feet thick and becomes increasingly interbedded with shale in the upper 20 feet and 4) skeletal to oolitic calcarenite and calcareous shale which attains 13 feet in thickness.

Dissepimental corals, *Neokoninckophyllum variabile,* are found on a single 4-feet high hummock in unit 3 approximately 15 feet below the top. The corals are present near the crest of the hummock. Most are in growth position. Fusulines, echinoid spines, long articulated crinoid stems, *Composita* sp., and fenestrate bryozoans make up the accompanying fauna.

The Captain Creek Limestone is incompletely exposed here. It is an algal calcilutite to sparry algal calcilutite approximately 10 feet thick. *Neokoninckophyllum heckeli* Cocke, n. sp., occurs in a zone approximately 4 feet from the base. Individuals are surrounded by sparry algal calcilutite and none are in growth position.

LOCALITY Pb13

NE NE sec. 3, T. 29 S., R. 15 E., Wilson County, Kansas. West side of a southeast-flowing stream, 4 miles east and 1 mile north of Fredonia, Kansas.

As much as 20 feet of oolitic calcarenite is present. The beds dip eastward, as opposed to the general gentle west dip of Pennsylvanian units. A single specimen of *Neokoninckophyllum variabile* was found. The epitheca is missing and the specimen is encrusted by a massive bryozoan. Accompanying fauna includes lophophyllid corals, bryozoans, *Dielasma* sp., *Composita* sp., *Myalina* sp., and crinoid cups representing several crinoid genera.

STANTON FORMATION

LOCALITY St1

NE sec. 18, T. 29 S., R. 16 E., Wilson County, Kansas. Roadcut on Kansas Highway 47, 1.5 miles west of Altoona, Kansas. Highest limestone unit is exposed. Both Plattsburg and lower Stanton Formations are exposed here. Neither unit is an algal mound here but less than 2 miles southwest, both form typical algal-mound complexes.

The Plattsburg is approximately 20 feet thick and consists of interbedded sponge-rich calcilutite and calcareous shale beds. The alga *Archaeolithophyllum* sp. is locally abundant. No dissepimental corals were collected.

The lowest Stanton (Captain Creek or Stoner) is a 35- to 40-feet thick channel deposit of skeletal calcarenite. It is extensively cross-bedded. Skeletal grains largely consist of crinoid stem fragments, fenestrate bryozoans, brachiopods, phylloid algal remains and sponges. The bryozoan *Glyptopora* sp. and the brachiopod *Schizophoria* sp. occur here. In Kansas these have been collected only from the channel deposits or associated facies. Abraded specimens of *Neokoninckophyllum heckeli, Dibunophyllum valeriae, Caninia torquia,* and *Geyerophyllum cylindricum* occur sporadically throughout the unit.

LOCALITY St2

See Loc. Pb8.

LOCALITY St3

SW SW NW sec. 23, T. 29 S., R. 14 E., Wilson County, Kansas. In a small stock pond approximately 1.5 miles south and 1 mile west of Fredonia, Kansas. Surface exposure of lower Stanton channel calcarenite; not measured.

A few feet of skeletal calcarenite particularly rich in crinoid and bryozoan debris is exposed here. *Caninia torquia, Neokoninckophyllum heckeli, Dibunophyllum valeriae,* and *Geyerophyllum cylindricum* are abundant. All are extensively abraded.

LOCALITY St4

Center sec. 16, T. 32 S., R. 15 E., Montgomery County, Kansas. In an abandoned quarry approximately 3 miles northwest of Independence, Kansas. Measurements are approximate.

Approximately 30 feet of massive algal calcilutite of the Captain Creek Limestone are overlain by 10 to 15 feet of calcareous shale and limestone in prominent swells and swales. *Dibunophyllum valeriae* is rare in the calcareous shale. The diverse and abundant accompanying fauna includes *Lophophyllidium* sp., ramose and fenestrate bryozoans, *Composita* sp., *Punctospirifer* sp., *Hustedia* sp., *Antiquatonia* sp., gastropods, pelecypods, and several crinoid genera, including abundant *Lecythiocrinus* sp.

LOCALITY St5

Center south line, sec. 22, T. 29 S., R. 15 E., Wilson County, Kansas. On east-west county road, 4.5 miles west and 1 mile south of Altoona, Kansas. Section not measured. Corals were collected from float in the road ditch. *Neokoninckophyllum heckeli* and *Dibunophyllum parvum* are found in algal calcilutite of the lower to middle Stanton Formation.

LOCALITY St8

NW NW NW sec. 28, T. 31 S., R. 15 E., Montgomery County, Kansas. In small quarry on the south side of east-west county road, 4 miles west of Sycamore, Kansas.

Eight feet of the Captain Creek Limestone Member is exposed. The lower 5 feet is an algal-poor, fossiliferous calcilutite. The fauna is dominated by fusulinids, echinoid spines, and crinoid stems. Large basket-shaped calcisponges measuring 2 feet in diameter and 6 inches in height are common on the quarry floor. Specimens of *Neokoninckophyllum heckeli* and *Dibunophyllum valeriae* occur abundantly in growth position on the surface of the sponges. In addition, other specimens lie inside the concave center of the sponge or are scattered unevenly around the outer periphery.

LOCALITY St10

SE SE sec. 27, T. 25 S., R. 17 E., Woodson County, Kansas. Section not measured. Corals were collected from float in north-south county road ditch. Several feet of Stoner? channel calcarenite are poorly exposed. *Neokoninckophyllum heckeli* is rare.

LOCALITY St11

SW SW SE sec. 4, T. 29 S., R. 15 E., Montgomery County, Kansas. New roadcut 0.5 mile northwest of Elk River Dam, approximately 5 miles northwest of Independence, Kansas. Section measured by P. H. HECKEL.

The entire Stanton is exposed. It consists largely of phylloid algal calcilutite with lesser thicknesses of invertebrate-rich calcilutites, fossiliferous shale and sandstone. Total thickness of the Stanton is approximately 120 feet. The Captain Creek Member is 65 feet thick, Eudora Shale 10 to 15 feet, Stoner Limestone 20 feet, Rock Lake Shale 2 feet, and the South Bend Limestone 22 feet. In addition, several feet of the underlying Vilas Shale and overlying Weston Shale is exposed. Dissepimental corals are present in the Captain Creek and the South Bend Limestones.

Neokoninckophyllum heckeli COCKE, n. sp., and *Dibunophyllum valeriae* occur in a 2- to 3-feet interval of invertebrate-rich calcilutite approximately 10 feet from the base of the Captain Creek Limestone. Algae-rich calcilutites overlie and underlie the interval. The corals are rare and none were in growth position. Accompanying fauna includes abundant fusulinids, fenestrate bryozoans, crinoid stems, and lesser numbers of *Enteletes* sp., *Composita* sp., and productids.

Dibunophyllum dibolium COCKE, n. sp., is found in algal calcilutite and sparry algal calcilutite approximately 7 feet from the top of the South Bend Limestone. None are in growth position. The accompanying sparse fauna includes crinoid stems and productids.

LOCALITY St14

NE SE sec. 2, T. 28 S., R. 15 E., Wilson County, Kansas. In abandoned quarry. Section not measured precisely. Approximately 27 feet of lower Stanton (Captain Creek) is exposed. The lower 25 feet is composed of algal-rich calcilutite and the upper 2 feet is skeletal calcarenite. *Neokoninckophyllum heckeli* and *Dibunophyllum parvum* have been collected from the uppermost surface of the algal limestone and from float derived from this interval.

LOCALITY St16

SE SW sec. 7, T. 30 S., R. 15 E., Wilson County, Kansas. Approximately 7 miles northwest of Neodesha, Kansas, in an abandoned quarry. Section not measured precisely.

Twenty feet of Captain Creek algal calcilutite is exposed here. *Neokoninckophyllum heckeli, Dibunophyllum parvum,* and *Geyerophyllum cylindricum* occur sporadically throughout the unit.

LOCALITY St17

NE NE sec. 15, T. 28 S., R. 15 E., Wilson County, Kansas. In an abandoned quarry south of railroad tracks less than 1 mile south of Benedict, Kansas. Section not measured precisely. Approximately 33 feet of Stoner Limestone is exposed.

Four units are recognized: 1) a basal 22 feet of algal-rich calcilutite, 2) 1-foot of fossiliferous calcareous shale, 3) 7 feet of algal invertebrate-rich calcilutite and calcarenite, and 4) 3.5 feet of fusulinid and bryozoan-rich skeletal calcarenite. Poorly preserved abraded *Caninia torquia* and *Dibunophyllum parvum* are moderately abundant in unit 4.

LOCALITY St18

SE SW sec. 3, T. 13 S., R. 21 E., Douglas County, Kansas, on Kansas Highway 10, approximately 1.5 miles east of Eudora, Kansas.

Eight feet of Stoner Limestone are exposed and overlie 5 feet of Eudora Shale. The Stoner consists of well-bedded fossiliferous calcilutite to fine calcarenite. The only dissepimental coral collected is *Dibunophyllum parvum* which is restricted to bedding surfaces in the lower 1 foot of the unit. Accompanying fauna consists of small *Composita* sp. and crinoid stems.

LOCALITY St19

SW sec. 5, T. 31 S., R. 15 E., Montgomery County, Kansas, 1 mile north and 5 miles west of Brickton, Kansas. *Dibunophyllum parvum* and *D. valeriae* were collected from Stanton (?Stoner) float in a county road ditch. Section was not measured.

LOCALITY St20

SE NE sec. 22, T. 29 S., R. 14 E., Wilson County, Kansas. Surface exposure in pasture, on Odell farm approximately 1.5 miles south and 1.2 miles west of Fredonia, Kansas. Section was not measured.

Specimens were collected from the highest bedding surface exposed in the lower Stanton channel calcarenite. *Caninia torquia* is particularly abundant; *Neokoninckophyllum heckeli* and *Geyerophyllum cylindricum* are poorly represented.

LOCALITY St23

NE sec. 18, T. 32 S., R. 14 E., Montgomery County, Kansas. South bank of Elk River on both east and west side of county road bridge, approximately 1.5 miles south and slightly west of Elk City, Kansas.

Twenty feet of massive South Bend Member (Stanton Formation) is present. Invertebrate-rich calcilutite dominates the section although phylloid algal calcilutite is common. *Dibunophyllum dibolium* COCKE, n. sp., and poorly preserved *Neokoninckophyllum heckeli* COCKE, n. sp., occur in the lower 6 feet and are particularly common where fusulinids and echinoid spines are abundant. In addition, crinoid fragments, bryozoans, *Composita* sp., *Antiquatonia* sp., and *?Enteletes* sp. occur.

LOCALITY St26

SW SE sec. 28, T. 32 S., R. 14 E., Montgomery County, Kansas. On U.S. Highway 160 approximately 7 miles west of Independence, Kansas.

Five feet of nonalgal fossiliferous well-bedded calcilutites of the South Bend Member overlie several feet of sandstone. *Dibunophyllum dibolium* is found in growth position on the uppermost surface exposed and is accompanied by very abundant sponges, crinoid stems and cups and ramose bryozoan colonies.

LOCALITY St27

Center east line sec. 23, T. 18 S., R. 19 E., Franklin County, Kansas. In an abandoned quarry west side of north-south road. One mile south of Princeton, Kansas and 0.5 mile south of U.S. Highway 59.

Four members of the Stanton Formation are exposed here: Eudora black shale, 0.5 feet thick; Stoner Limestone, 11.5 feet; Rock Lake Shale consisting of 5.5 feet of limestone and thin shale; and South Bend, 4.9 feet. Only the Stoner Limestone contains dissepimental corals.

The Stoner consists of well-bedded fossiliferous calcilutite. Dissepimental corals are *Caninia torquia* and a single unidentifiable geyerophyllid. These occur sporadically in the upper 4 feet. Accompanying fauna includes fenestrate bryozoans, *Neospirifer* sp.,

Punctospirifer sp., *Composita* sp., *Enteletes* sp., *Linoproductus* sp., *Antiquatonia* sp., and abundant crinoid stems. The fauna and the dissepimental corals are concentrated largely along bedding surfaces.

LOCALITY St28

Middle of west line, SW 34, T. 12 S., R. 23 E., Johnson County, Kansas, on Kansas Highway 7 and 10, 1.2 miles south of intersection of the two highways.

Three members of the Stanton Formation are exposed: Captain Creek Limestone, 4.3 feet thick; Eudora Shale, 7.0 feet; Stoner Limestone, 5.2 feet. Only the Stoner Limestone contains dissepimental corals. Approximately 8.5 feet of underlying Vilas Shale is exposed.

The Stoner Limestone is a nonalgal calcilutite which in addition to rare specimens of *Dibunophyllum parvum* contains abundant invertebrates including fenestrate and ramose bryozoans, *Composita* sp., and crinoid stems. *D. parvum* is distributed unevenly throughout the limestone. None are in growth position.

LOCALITY St29

SE sec. 17, T. 13 S., R. 21 E., Douglas County, Kansas. In an abandoned quarry on east side of north-south county road. Measurements are approximate.

Ten to 12 feet of well-bedded fossiliferous calcilutites and fine calcarenites of the Stoner Member. No *in situ* corals were collected. A few *Caninia torquia* and a single questionable geyerophyllid have been collected from float blocks on the quarry floor.

EXPLANATION OF PLATES

PLATE 1

Dibunophyllum (Fig. 1-13); all figures ×1.75.

FIGURE

1. *Dibunophyllum valeriae* NEWELL, 1935, Loc. Wy3, Farley Limestone (Wyandotte Formation).——1a. Ext. side view.——1b. Transv. sec. badly silicified; counter-cardinal plane vertical; note prominent inner wall and typical dibunophylloid columella.——1c. Long. sec. perpendicular to counter-cardinal plane; note prominent inner wall.
2. *D. hystricosum* COCKE, n. sp., paratype (SUI 33903), Loc. Win3, Winterset Limestone (Dennis Formation). Transv. sec. in high ephebic stage.
3. *D. hystricosum* COCKE, n. sp., holotype (SUI 33904), Loc. BF6, Bethany Falls Limestone (Swope Formation).——3a. Transv. sec. near base of calyx; counter-cardinal plane vertical.——3b. Long. sec. perpendicular to counter-cardinal plane.
4. *D. hystricosum* COCKE, n. sp., paratype (SUI 33902), Loc. Win3, Winterset Limestone (Dennis Formation). Transv. sec.; counter-cardinal plane vertical; note well-developed dibunophylloid columella.
5. *D. hystricosum* COCKE, n. sp., Loc. BF1, Bethany Falls Limestone (Swope Formation). Ext. side view of small specimen.
6. *D. hystricosum* COCKE, n. sp., Loc. Win1, Winterset Limestone (Dennis Formation). Ext. side view of elongate specimen; note prominent calicular boss.
7. *D. hystricosum* COCKE, n. sp., Loc. BF1, Bethany Falls Limestone (Swope Formation). Transv. sec.; counter-cardinal plane vertical.
8. *D. valeriae* NEWELL, 1935, Loc. Pb1, Spring Hill Limestone (Plattsburg Formation).——8a. Transv. sec.; counter-cardinal plane vertical; note prominent inner wall and typically dibunophylloid columella.——8b. Long. sec. perpendicular to counter-cardinal plane.
9. *D. valeriae* NEWELL, 1935, Loc. Pb3, Spring Hill Limestone (Plattsburg Formation). Transv. sec. in calyx; counter-cardinal plane vertical; note lanceolate major septa and absence of minor septa in some interloculi.
10. *D. valeriae* NEWELL, 1935, Loc. Pb8, transitional beds between Plattsburg and Stanton Formations.——10a. Transv. sec. in high ephebic stage; note columella is not typically dibunophylloid and extreme shortness of minor septa.——10b. Long. sec. perpendiicular to counter-cardinal plane.
11. *D. valeriae* NEWELL, 1935, Loc. Pb8, Spring Hill Limestone (Plattsburg Formation). Transv. sec.; counter-cardinal plane vertical.
12. *D. valeriae* NEWELL, 1935, Loc. Pb1, Spring Hill Limestone (Plattsburg Formation). Transv. sec.; counter-cardinal plane vertical; note well-developed inner wall and dibunophylloid columella.
13. *D. valeriae* NEWELL, 1935, Loc. St2 (=Pb8), transitional beds between Plattsburg and Stanton Formations. Transv. sec.; counter-cardinal plane vertical.

PLATE 2

Dibunophyllum (Fig. 1-13), *Neokoninckophyllum* (Fig. 14-17); all figures ×2.5.

FIGURE

1. *Dibunophyllum bourbonense* COCKE, n. sp., holotype (SUI 33910), Loc. H7, Hertha Limestone Formation.——1a. Transv. sec. in ephebic stage; counter-cardinal plane vertical; note spinose character of radiating lamellae and the thinness of the median lamella.——1b. Long. sec. perpendicular to counter-cardinal plane.
2. *D. bourbonense* COCKE, n. sp., paratype (SUI 33909), Loc. H1, Hertha Limestone Formation.——2a. Transv. sec. in ephebic stage, counter-cardinal plane slightly oblique to vertical plane.——2b. Long. sec. perpendicular to counter-cardinal plane.
3. *D.* sp. cf. *D. bourbonense* COCKE, n. sp., specimen (SUI 33906) from Loc. H10, Hertha Limestone Formation.——3a. Transv. sec., counter-cardinal plane vertical; note wide dissepimentarium and stout median lamella.——3b. Long. sec. perpendicular to counter-cardinal plane; note rapid upward increase in width of dissepimentarium.——3c. Transv. sec. in low ephebic stage.
4. *D. clathrum* COCKE, n. sp., holotype (SUI 33900), Loc. Dr1, Cement City Limestone (Drum Formation).——4a. Transv. sec. in lower part of calyx, counter-cardinal plane vertical. ——4b. Long. sec. approximately perpendicular to counter-cardinal plane.
5. *D. clathrum* COCKE, n. sp., paratype (SUI 33899), Loc. Dr1, Cement City Limestone (Drum Formation).——5a. Transv. sec. short distance below base of the calyx; counter-cardinal plane vertical.——5b. Long. sec. perpendicular to counter-cardinal plane.

6. *D. dibolium* Cocke, n. sp., holotype (SUI 33897), Loc. St19, South Bend Limestone (Stanton Formation).——6a. Transv. sec. near base of calyx, counter-cardinal plane vertical; note thick lanceolate septa and closely packed columella.——6b. Long. sec. perpendicular to counter-cardinal plane; note change in inclination of dissepiments from edge of section to inner edge of the dissepimentarium.——6c. Trans. sec. in middle ephebic stage.
7. *D. dibolium* Cocke, n. sp., paratype (SUI 33896), Loc. St17, Stoner Limestone (Stanton Formation). Transv. sec. in calyx, counter-cardinal plane vertical; note thick lanceolate septa and closely spaced radiating lamellae.
8. *D. parvum* Cocke, 1969, holotype (KUMIP 500515), Loc. Wy3, Argentine Limestone (Wyandotte Formation).——8a. Transv. sec. below base of calyx; counter-cardinal plane vertical; note thinness of major septa.——8b. Long. sec. perpendicular to counter-cardinal plane.
9. *D. parvum* Cocke, 1969, topotype, Loc. Wy3, Argentine Limestone (Wyandotte Formation). Transv. sec. in calyx, counter-cardinal plane vertical.
10. *D. parvum* Cocke, 1969, topotype, Loc. Wy3, Argentine Limestone (Wyandotte Formation). Ext. side view; note septa rising above upper limit of epitheca.
11. *D. parvum* Cocke, 1969, topotype, Loc. Wy3, Argentine Limestone (Wyandotte Formation).——11a. Transv. sec. in lower part of calyx, counter-cardinal plane vertical; note thinness of major septa and spacing of dissepiments.——11b. Transv. sec. in neanic stage; note vertical counter-cardinal crossbar.
12. *Dibunophyllum elegente* Cocke, n. sp., holotype (SUI 33894), Loc. I2, Raytown Limestone (Iola Formation).——12a. Transv. sec. in high ephebic stage; counter-cardinal plane vertical; note weak development of dibunophylloid columella.——12b. Long. sec. perpendicular to counter-cardinal plane.
13. *D. elegente* Cocke, n. sp., paratype (SUI 33893), Loc. I2, Raytown Limestone (Iola Formation). Transv. sec. near calyx, counter-cardinal plane vertical; note dibunophylloid columella.
14. *Neokoninckophyllum petilum* Cocke, n. sp., holotype (SUI 33884), Loc. Bk1, Block Limestone (Cherryvale Formation).——14a. Transv. sec. in ephebic stage; position of primary septa unknown.——14b. Long. sec.
15. *N. petilum* Cocke, n. sp., paratype (SUI 33883), Loc. Bk1, Block Limestone (Cherryvale Formation). Transv. sec., ephebic stage, position of primary septa unknown.
16. *N. petilum* Cocke, n. sp., Loc. Bk1, Block Limestone (Cherryvale Formation). Long. sec.; relation to counter-cardinal plane unknown.
17. *N. petilum* Cocke, n. sp., paratype (SUI 33882), Loc. Bk1, Block Limestone (Cherryvale Formation).——17a. Long. sec.; relation to counter-cardinal plane unknown.——17b. Transv. sec.; position of primary septa unknown; note scattered lonsdaleoid dissepiments.

PLATE 3

Neokoninckophyllum (Fig. 1-10); all figures ×1.75.

FIGURE

1. *Neokoninckophyllum kansasense* (Miller & Gurley, 1893), Loc. Wes2, Westerville Limestone (Cherryvale Formation). Intermediate between variants 1 and 2.——1a. Ext. side view parallel to curvature of early conical stage.——1b. Transv. sec. in high ephebic stage; position of primary septa unknown; note lack of columella and the moderately spaced dissepiments.——1c. Long. sec.; relation to counter-cardinal plane is unknown.
2. *N. kansasense* (Miller & Gurley, 1893), variant 2, Loc. Wes1, Westerville Limestone (Cherryvale Formation). Ext. view showing several small corallites originating from calyx of larger specimen.
3. *N. kansasense* (Miller & Gurley, 1893), variant 2, Loc. Wes2, Westerville Limestone (Cherryvale Formation). Transv. sec. in high ephebic stage; position of counter and cardinal septa is unknown.
4. *N. kansasense* (Miller & Gurley, 1893), variant 2, Loc. Wes2, Westerville Limestone (Cherryvale Formation).——4a. Transv. sec. in high ephebic stage; position of primary septa is unknown; note lack of columellar structure and presence of small, closely packed and highly curved dissepiments.——4b. Long. sec.; relation to counter-cardinal plane is unknown.
5. *N. kansasense* (Miller & Gurley, 1893), Loc. Wes2, Westerville Limestone (Cherryvale Formation). Intermediate between variants 1 and 2. Transv. sec.; location of primary septa unknown; note extension of a few major septa to central area of section.
6. *N. kansasense* (Miller & Gurley, 1893), variant 1, Loc. Wes1, Westerville Limestone (Cherryvale Formation).——6a. Transv. sec.; position of primary septa is unknown; note narrow dissepimentarium consisting of moderately spaced dissepiments.——6b. Long. sec.; relation to counter-cardinal plane unknown.
7. *N. kansasense* (Miller & Gurley, 1893), variant 1, Loc. Wes1, Westerville Limestone (Cherryvale Formation).——7a. Transv. sec., position of primary septa unknown; note narrow dissepimentarium consisting of moderately spaced dissepiments.——7b. Long. sec.; relation to counter-cardinal plane unknown.
8. *N. kansasense* (Miller & Gurley, 1893), variant 1, Loc. Wes1, Westerville Limestone (Cherryvale Formation). Ext. calicular view of small colony.
9. *N. kansasense* (Miller & Gurley, 1893), variant 1, Loc. Wes1, Westerville Limestone (Cherryvale Formation).——9a. Ext. side view of elongate corallite.——9b. Transv. sec. several millimeters below calyx floor; position of primary septa unknown; note major septa extending to center of corallite.
10. *N. kansasense* (Miller & Gurley, 1893), variant 1, Loc. Wes1, Westerville Limestone (Cherryvale Formation). Transv. sec. near base of calyx; position of primary septa unknown.

PLATE 4

Neokoninckophyllum (Fig. 1-14); all figures ×1.75.

FIGURE

1. *Neokoninckophyllum tushanense* (Chi, 1931) specimen (SUI 33878) from Loc. Win1, Winterset Limestone (Dennis Formation).——1a. Transv. sec. in high ephebic stage; position of primary septa unknown; note lack of columella.——1b. Ext. side view parallel to plane of curvature.
2. *N. tushanense* (Chi, 1931), specimen (SUI 33877) from Loc. Win1, Winterset Limestone (Dennis Formation).——2a. Ext. side view of silicified specimen, parallel to plane of curvature.——2b. Transv. sec.; position of primary septa unknown.

3. *N. tushanense* (Chi, 1931), specimen (SUI 33876), from Loc. Win1, Winterset Limestone (Dennis Formation).——3a. Ext. side view in plane of curvature.——3b. Transv. sec.; position of primary septa unknown; note bending of major septa as they approach central area.——3c. Long sec.; relation to counter-cardinal plane unknown.
4. *N. tushanense* (Chi, 1931), Loc. Win1, Winterset Limestone (Dennis Formation). Transv. sec.; note prominent lonsdaleoid dissepiments and shortness of major septa.
5. *N. tushanense* (Chi, 1931), Loc. Win1, Winterset Limestone (Dennis Formation). Transv. sec. of badly silicified specimen; note extension of counter? septum into central region.
6. *N. tushanense* (Chi, 1931), Loc. BF6, Bethany Falls Limestone (Swope Formation).——6a. Transv. sec., ephebic stage; position of primary septa unknown.——6b. Long. sec.; relation to counter-cardinal plane unknown.
7. *N. tushanense* (Chi, 1931), Loc. BF6, Bethany Falls Limestone (Swope Formation).——7a. Transv. sec. in calyx, position of primary septa unknown.——7b. Long. sec.; relation to counter-cardinal plane unknown.
8. *N. perplexum* Cocke, n. sp., paratype (SUI 33891); Loc. H3, Hertha Limestone Formation. Transv. sec., ephebic stage; note counter? septum forms columella; also note narrow dissepimentarium and short spinelike local minor septa.
9. *N. perplexum* Cocke, n. sp., paratype (SUI 33889), Loc. H3, Hertha Limestone Formation. Transv. sec.; note counter? septum bifurcates in central area.
10. *N. perplexum* Cocke, n. sp., Loc. H3, Hertha Limestone Formation.——10a. Transv. sec., ephebic stage, position of primary septa unknown; note absence of columella.——10b. Long. sec.
11. *N. perplexum* Cocke, n. sp., holotype (SUI 33890), Loc. H7, Hertha Limestone Formation.——11a. Transv. sec.; position of counter and cardinal septa uncertain; note narrow dissepimentarium and isolated columella.——11b. Long. sec. perpendicular to counter-cardinal plane.
12. *N.* sp. A, specimen (SUI 33888) from Loc. H1, Hertha Limestone Formation.——12a. Transv. sec.; position of primary septa unknown; note prominent lonsdaleoid dissepimentarium and lack of minor septa.——12b. Long. sec.; relation to counter-cardinal plane uncertain.
13. *N. acolumnatum* Cocke, n. sp., paratype (SUI 33885), Loc. Win1, Winterset Limestone (Dennis Formation).——13a. Transv. sec., ephebic stage; position of primary septa unknown; note lack of minor septa and columella.——13b. Long. sec.; relation to counter-cardinal plane unknown.——13c. Transv. sec., low ephebic stage.
14. *N. acolumnatum* Cocke, n. sp., Loc. Win1, Winterset Limestone (Dennis Formation).——14a. Trans. sec., ephebic stage, position of primary septa unknown; note presence of minor septa in some interseptal loculi.——14b. Long. sec.; relation to counter-cardinal plane unknown; note narrow dissepimentarium.

PLATE 5

Neokoninckophyllum (Fig. 1-11); all figures ×1.75.

FIGURE

1. *Neokoninckophyllum acolumnatum* Cocke, n. sp., paratype (SUI 33886), Loc. Pb8, transitional beds between Plattsburg and Stanton Formations.——1a. Transv. sec. in ephebic stage; position of primary septa unknown.——1b. Ext. side view.
2. *N. acolumnatum* Cocke, n. sp., holotype (SUI 33887), Loc. Pb8, transitional beds between Plattsburg and Stanton Formations.——2a. Transv. sec., ephebic stage; position of primary septa unknown; note thinness of all elements and the presence of lonsdaleoid dissepiments.——2b. Long. sec.; relation to counter-cardinal plane unknown; note widely spaced irregular tabulae.
3. *N. variabile* Cocke, n. sp., paratype (SUI 33868), Loc. Pb4, Spring Hill Limestone (Plattsburg Formation). Transv. sec. in ephebic stage; position of primary septa unknown; note close packing of dissepiments and filamentous nature of columella.
4. *N. variabile* Cocke, n. sp., holotype (SUI 33869), Loc. Pb3, Spring Hill Limestone (Plattsburg Formation).——4a. Transv. sec. in ephebic stage short distance below calyx; position of primary septa unknown; note radial pattern of columella, lack of minor septa and close packing of dissepiments.——4b. Long. sec.; relation to counter-cardinal plane unknown; note change in columella character vertically.——4c. Transv. sec. in low ephebic stage; position of primary septa unknown; note loose meshwork of septal lamellae in central area and moderate spacing of dissepiments.——4d. Ext. side view.
5. *N. variabile* Cocke, n. sp., paratype (SUI 33867), Loc. Pb8, transitional beds between Plattsburg and Stanton Formations. Transv. sec. in ephebic stage; position of primary septa unknown; note irregular axial structure.
6. *N. variabile* Cocke, n. sp., paratype (SUI 33866), Loc. Pb1, Spring Hill Limestone (Plattsburg Formation). Ext. view of budding corallite.
7. *N. variabile* Cocke, n. sp., paratype (SUI 33865), Loc. Pb8, transitional beds between Plattsburg and Stanton Formations.——7a. Transv. sec. in ephebic stage; position of primary septa unknown; note loose meshwork in central area, lack of minor septa and wide spacing of most elements.——7b. Long. sec.; relation to counter-cardinal plane unknown.——7c. Transv. sec. in low ephebic stage; position of primary septa unknown; note presence of spinelike minor septa in a few interseptal loculi.
8. *N. variabile* Cocke, n. sp., paratype (SUI 33864), Loc. Pb3, Spring Hill Limestone (Plattsburg Formation).——8a. Transv. sec. in high ephebic stage; position of primary septa unknown; note columella consists of loose meshwork of septal elements and tabulae.——8b. Long. sec.; relation to counter-cardinal plane unknown.
9. *N. variabile* Cocke, n. sp., paratype (SUI 33863), Loc. Pb8, transitional beds between Plattsburg and Stanton Formations; transv. sec. in high ephebic stage; counter-cardinal plane vertical; note presence of prominent median lamella and lack of minor septa in most interseptal loculi.
10. *N. variabile* Cocke, n. sp., Loc. Wy1, Farley Limestone (Wyandotte Formation).——10a. Long. sec., perpendicular to counter-cardinal plane; note well-developed median lamella.——10b. Transv. sec. in middle ephebic stage; counter-cardinal plane vertical.
11. *N. variabile* Cocke, n. sp., Loc. Pb6, Spring Hill Limestone (Plattsburg Formation). Transv. sec. near base of calyx; counter-cardinal plane vertical; note extension of ?counter septum into central area.

PLATE 6

Canina (Fig. 1-7), *Neokoninckophyllum* (Fig. 8-9); all figures ×1.75.

FIGURE

1. *Caninia linnensis* Cocke, n. sp., holotype (SUI 33881), Loc. H3, Hertha Limestone Formation.——1a. Transv. sec. in high ephebic stage; position of primary septa not known; note absence of prominent fossulae and minor septa.——1b. Long. sec.; relation to counter-cardinal plane unknown.——1c. Transv. sec. in middle ephebic stage.
2. *C. linnensis* Cocke, n. sp., paratype (SUI 33880), Loc. H3, Hertha Limestone Formation. Transv. sec., ephebic stage; position of primary septa unknown.
3. *C. torquia* (Owen, 1852), Loc. Dr1, Cement City Limestone, Drum Formation.——3a. Long. sec. perpendicular to counter-cardinal plane.——3b. Transv. sec., low ephebic stage, counter-cardinal plane vertical.
4. *C. torquia* (Owen, 1852), Loc. Dr1, Cement City Limestone, Drum Formation.——4a. Transv. sec., in ephebic stage near base of calyx; note prominent fossula in upper part of section. ——4b. Transv. sec., neanic stage; note absence of fossula.
5. *C. torquia* (Owen, 1852), Loc. Dr1, Cement City Limestone, Drum Formation.——5a. Transv. sec. in calyx; position of primary septa unknown; note prominent minor septa and absence of cyathopsid thickening.——5b. Long. sec.; relation to counter-cardinal plane unknown.
6. *C. torquia* (Owen, 1852), Loc. St10, Stoner Limestone, Stanton Formation. Transv. sec. in high ephebic stage, cardinal fossula in top of section; note presence of cyathopsid thickening in cardinal quadrants and prominence of minor septa.
7. *C. torquia* (Owen, 1852), Loc. St10, Stoner Limestone, Stanton Formation.——7a. Transv. sec., high ephebic stage, cardinal fossula at top of section; note presence of cyathopsid thickening in cardinal quadrants and prominence of minor septa.——7b. Transv. sec. in low ephebic stage; cardinal fossula at top of section; note presence of cyathopsid thickening in cardinal quadrants and prominence of minor septa.
8. *Neokoninckophyllum heckeli* Cocke, n. sp., holotype (SUI 33872), Loc. St8, lower Stanton Formation.——8a. Long. sec.; relation to counter-cardinal plane unknown.——8b. Transv. sec., middle ephebic stage; position of primary septa unknown; note looseness of central structure.
9. *N. heckeli* Cocke, n. sp., paratype (SUI 33871), Loc. St8, lower Stanton Formation.——9a. Transv. sec., high ephebic stage; position of primary septa unknown; note looseness of central structure.——9b. Long. sec.; relation to counter-cardinal plane unknown.

PLATE 7

Geyerophyllum (Fig. 1-10); all figures ×1.75.

FIGURE

1. *Geyerophyllum jewetti* Cocke, n. sp., holotype (SUI 33930), Loc. H2, Hertha Limestone.——1a. Transv. sec. in high ephebic stage; note abundant irregular lonsdaleoid dissepiments and small columella.——1b. Long. sec. perpendicular to counter-cardinal plane; note wide dissepimentarium and anastomosing tabulae.
2. *G. jewetti* Cocke, n. sp., Loc. H1, Hertha Limestone. Transv. sec. in ephebic stage.
3. *G. jewetti* Cocke, n. sp., Loc. H2, Hertha Limestone. Long. sec. perpendicular to counter-cardinal plane.
4. *G. jewetti* Cocke, n. sp., paratype (SUI 33929), Loc. H2, Hertha Limestone. Transv. sec. in calyx of widely flaring corallite.
5. *G. jewetti* Cocke, n. sp., paratype (SUI 33928), Loc. H1, Hertha Limestone. Transv. sec. in ephebic stage of small corallite; note the irregular columella.
6. *G. patulum* Cocke, n. sp., holotype (SUI 33924), Loc. Bk1, Block Limestone Member (Cherryvale Formation).——6a. Transv. sec., high ephebic stage; noted wide lonsdaleoid dissepimentarium consisting of smoothly curved dissepiments; also note the complexity of the columella.——6b. Long. sec. perpendicular to counter-cardinal plane; note the width and complexity of the columella and the anastomosing nature of the tabulae.
7. *G. patulum* Cocke, n. sp., paratype (SUI 33925), Loc. Bk1, Block Limestone Member (Cherryvale Formation).——7a. Transv. sec., high ephebic stage; note lonsdaleoid dissepiments somewhat less evenly disposed than those in holotype; also note the complexity of the columella.——7b. Long. sec. perpendicular to counter-cardinal plane; note the attachment spine on right side of specimen and also the nature of the columella.
8. *G.* sp. A, specimen SUI 33927; for locality information, see description of species. Transv. sec. of small incomplete corallite; note large lonsdaleoid dissepiments and the thin simple columella.
9. *G. girtyi* Cocke, n. sp., holotype (SUI 33923), Loc. Dr1, Cement City Member, Drum Formation.——9a. Transv. sec., in calyx; note irregular distribution of lonsdaleoid dissepiments.——9b. Long. sec. perpendicular to counter-cardinal plane; note the uneven outline of the columella.
10. *G. girtyi* Cocke, n. sp., paratype (SUI 33922), Loc. Dr1, Cement City Member, Drum Formation.——10a. Ext. view; note prominent ribbing and attachment spines.——10b. Ext. view showing the flat floor of the outer calyx and the inner cylindrical portion with a prominent boss.

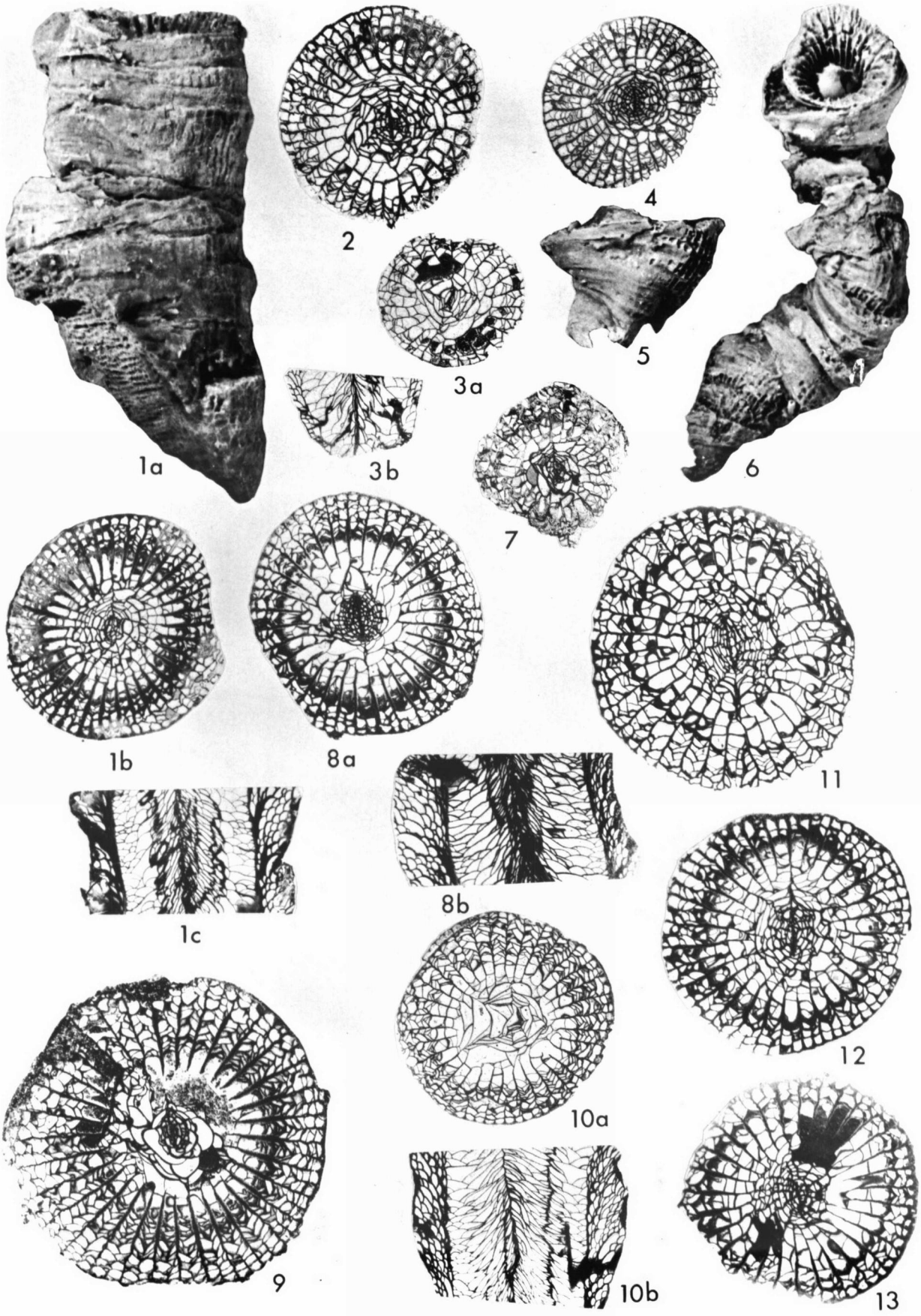
PLATE 8

Geyerophyllum (Fig. 1-15); all figures ×1.75.

FIGURE

1. *Geyerophyllum* sp. cf. *G. broilii* Heritsch, 1936, specimen SUI 33914, Loc. Wy1, Farley Limestone (Wyandotte Formation).——1a. Transv. sec. in high ephebic stage; note irregular distribution of lonsdaleoid dissepiments.——1b. Long. sec. perpendicular to counter-cardinal plane; note growth increments in columella.
2. *G.* sp. cf. *G. broilii* Heritsch, 1936, Loc. Wy1, Farley Limestone (Wyandotte Formation). Ext. view of well-preserved corallite showing flaring shape, well-developed longitudinal ribbing and attachment spines.
3. *G.* sp. cf. *G. broilii* Heritsch, 1936, specimen (SUI 33913), from Loc. Pb4, Spring Hill Limestone (Plattsburg Formation). Transv. sec. in high ephebic stage; note smooth columella.
4. *G.* sp. cf. *G. broilii* Heritsch, 1936, specimen (SUI 33912), from Loc. Wy3, Farley Limestone (Wyandotte Formation). Transv. sec. in high ephebic stage of badly silicified specimen; note sparseness of lonsdaleoid dissepiments and stellate columella.

5. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Wy3, Farley Limestone (Wyandotte Formation). Transv. sec. of badly silicified specimen.
6. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Pb4, Spring Hill Limestone (Plattsburg Formation). Transv. sec. of high ephebic stage.
7. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Pb4, Spring Hill Limestone (Plattsburg Formation).——7a. Transv. sec. in calyx; note irregular distribution of lonsdaleoid dissepiments. —7b. Long. sec. perpendicular to counter-cardinal plane; note irregular outline of the columella.
8. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Pb4, Spring Hill Limestone (Plattsburg Formation). Ext. view of exceptionally well-preserved specimen.
9. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Pb4, Spring Hill Limestone, Plattsburg Formation.——9a. Transv. sec. short distance below base of calyx.——9b. Long. sec. perpendicular to counter-cardinal plane.
10. *G.* sp. cf. *G. broilii* HERITSCH, 1936, Loc. Pb4, Spring Hill Limestone (Plattsburg Formation); ext. of small well-preserved corallite.
11. *G. garnettense* COCKE, n. sp., holotype (SUI 33917), Loc. Pb5, Spring Hill Limestone (Plattsburg Formation).——11a. Transv. sec. near base of calyx; note closely spaced dissepimentarium.——11b. Long. sec. perpendicular to counter-cardinal plane.
12. *G. garnettense* COCKE, n. sp., paratype (SUI 33916), Loc. Pb5, Spring Hill Limestone (Plattsburg Formation).——12a. Transv. sec. in high ephebic stage.——12b. Long. sec. perpendicular to counter-cardinal plane.
13. *G. garnettense* COCKE, n. sp., paratype (SUI 33915), Loc. Pb5, Spring Hill Limestone (Plattsburg Formation). Transv. sec. in calyx.
14. *G. cylindricum* (DOBROLYUBOVA & KABAKOVICH, 1948), Loc. St20, lower part of Stanton Formation.——14a. Transv. sec. high in ephebic stage of badly preserved specimen; note loose denticulate pattern of columella and lack of lonsdaleoid dissepiments.——14b. Long. sec. perpendicular to counter-cardinal plane; note reticulate nature of the columella.
15. *G. cylindricum* (DOBROLYUBOVA & KABAKOVICH, 1948), Loc. St20, lower part of Stanton Formation. Transv. sec. in ephebic stage; note lack of lonsdaleoid dissepiments and the solid denticulate columella.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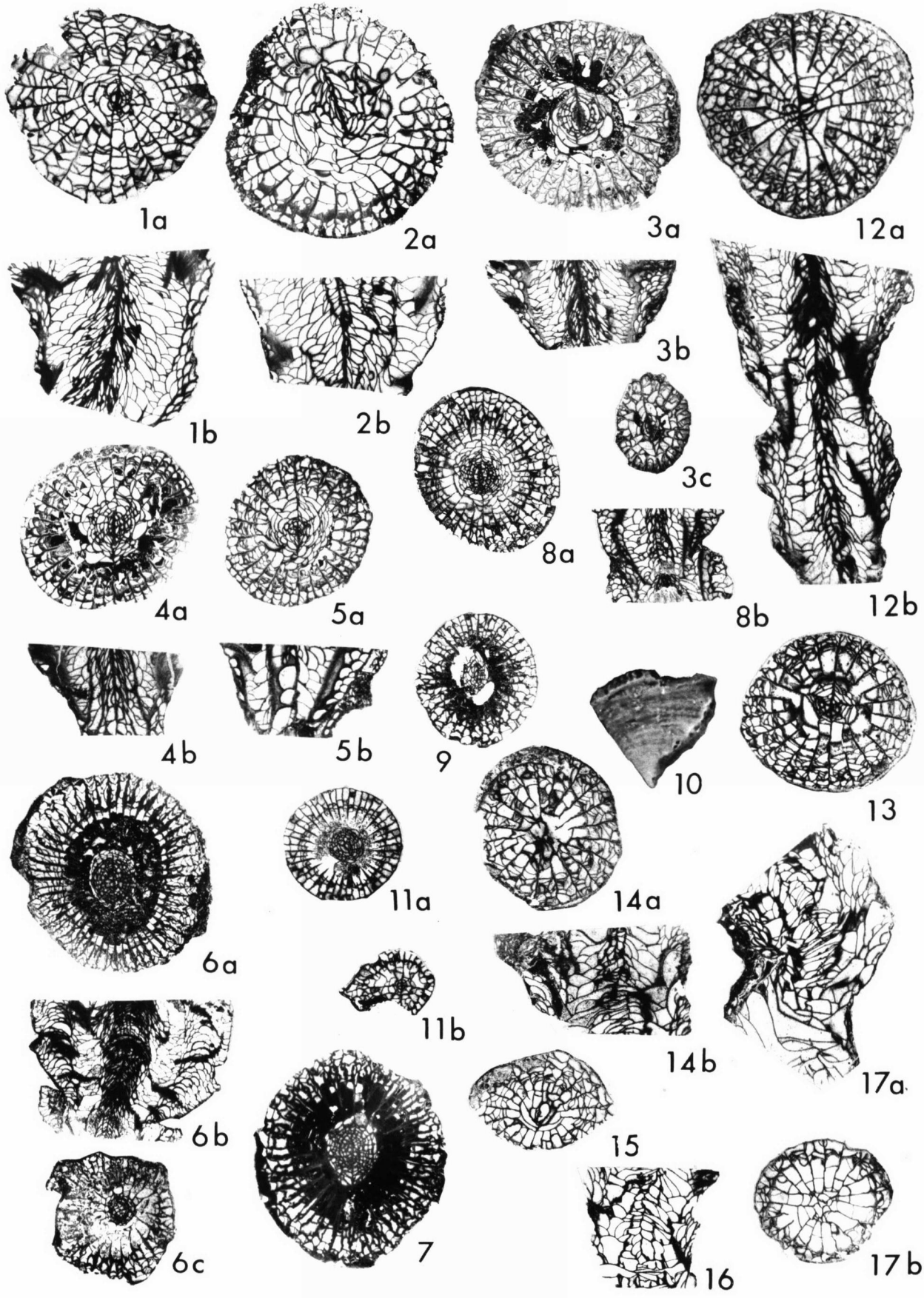
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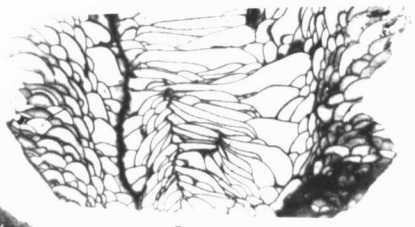

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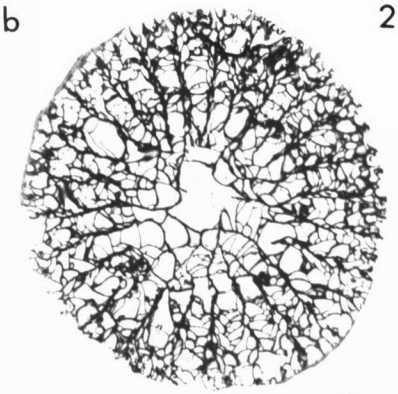

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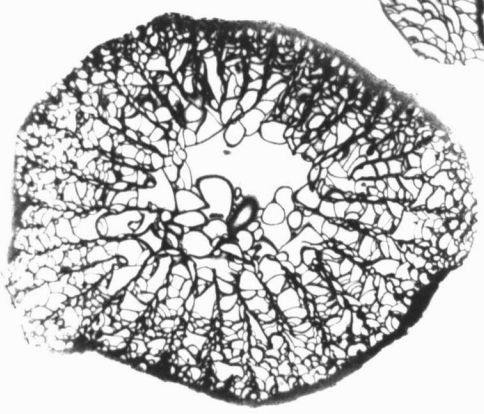

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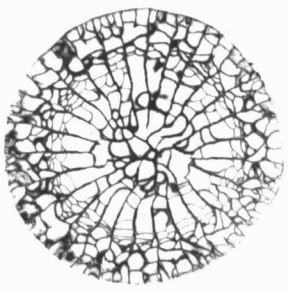

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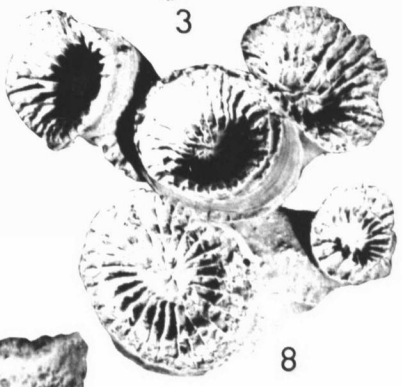

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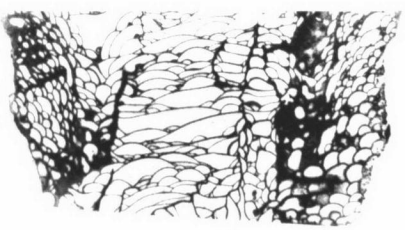

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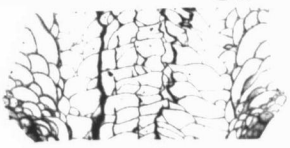

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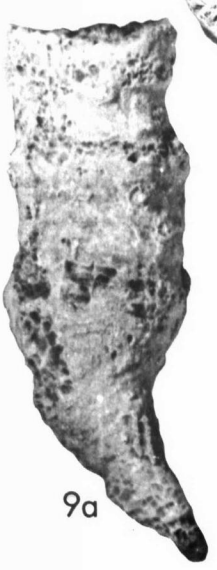

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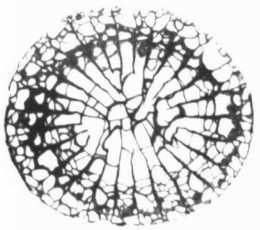

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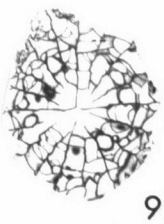

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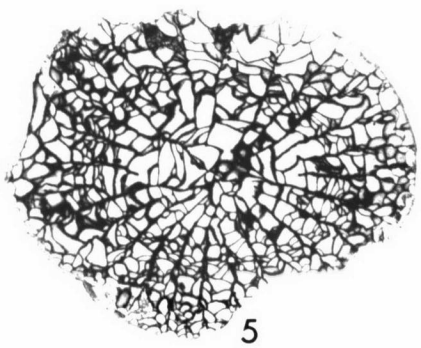

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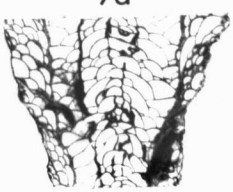

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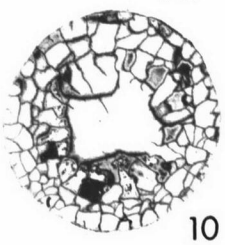

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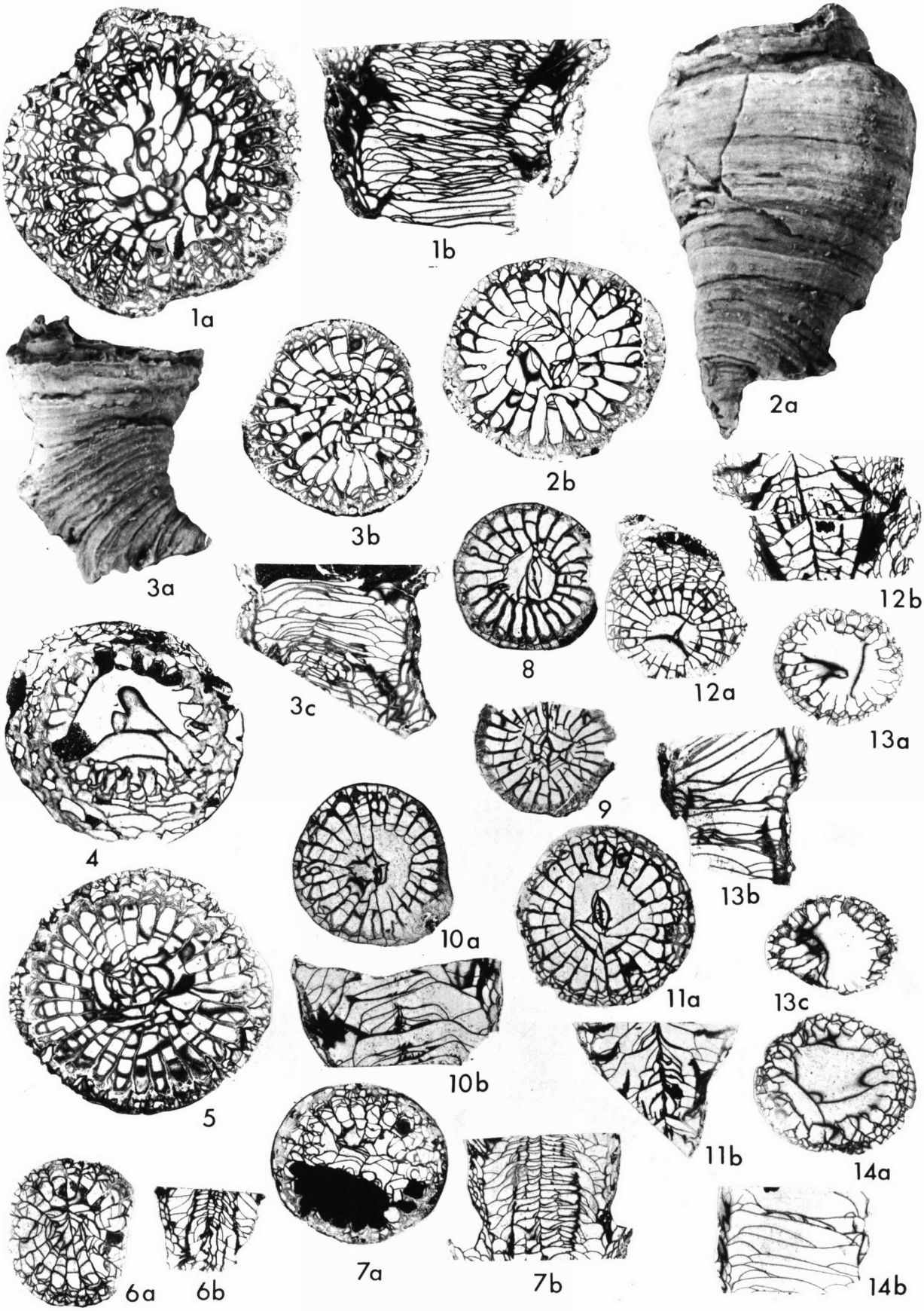
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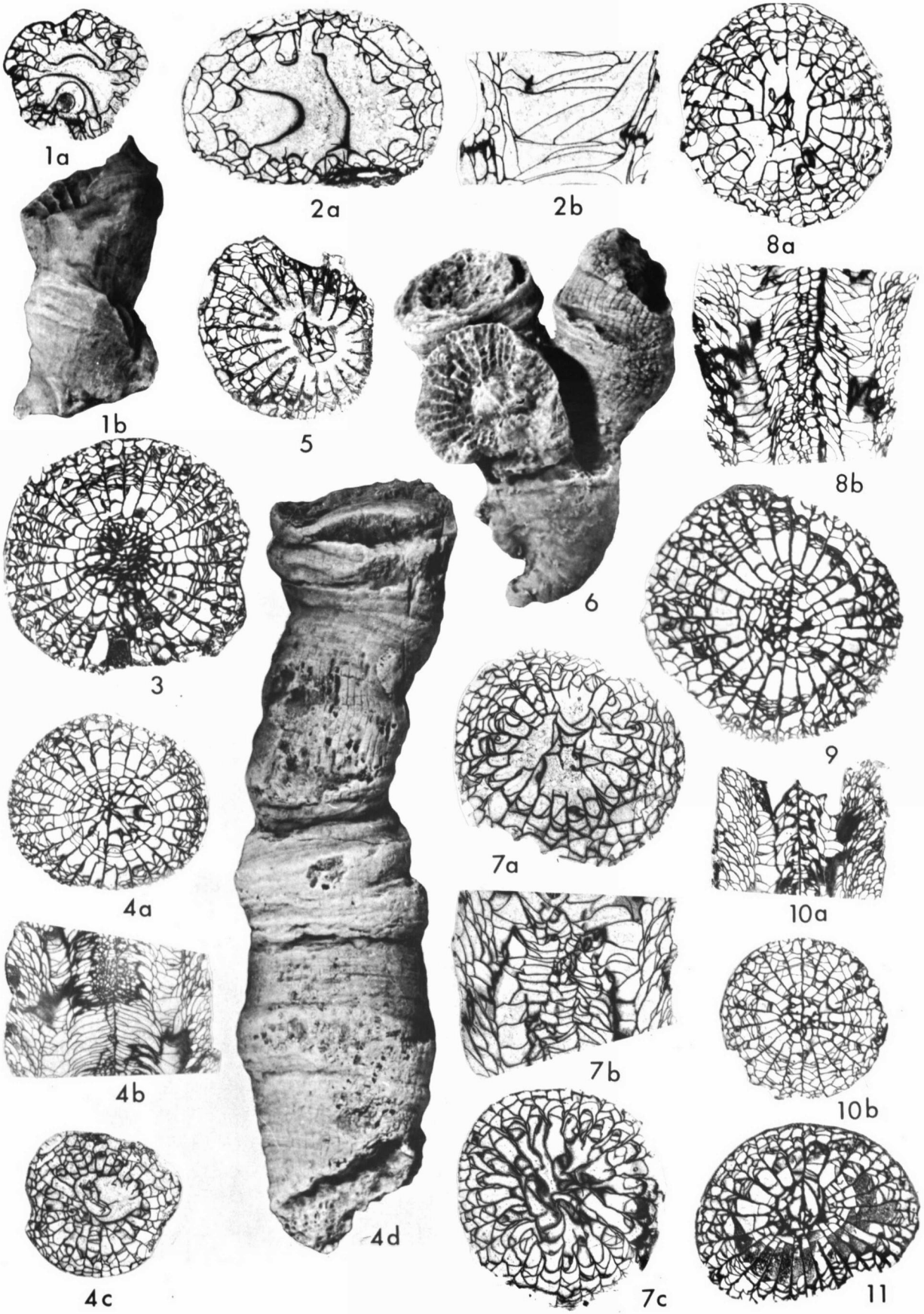
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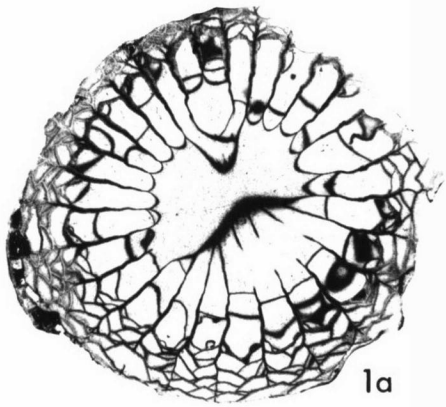
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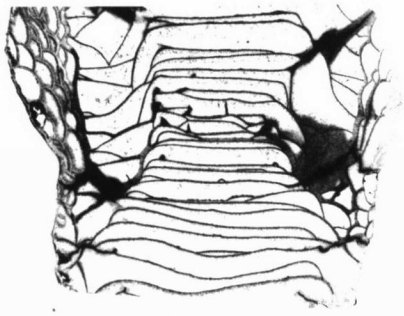
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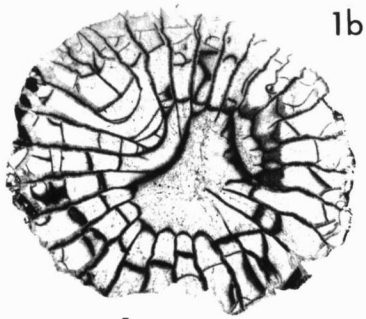
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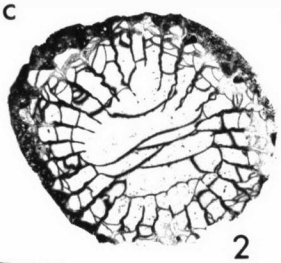
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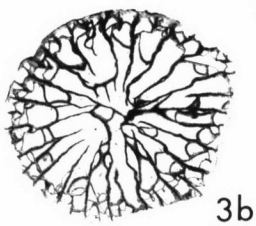
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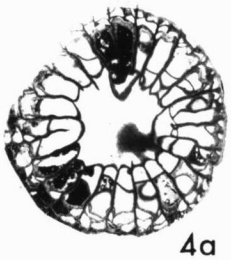
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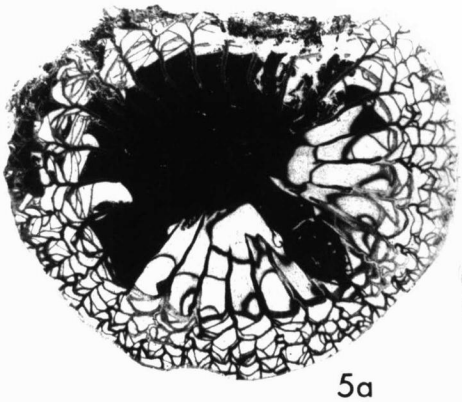
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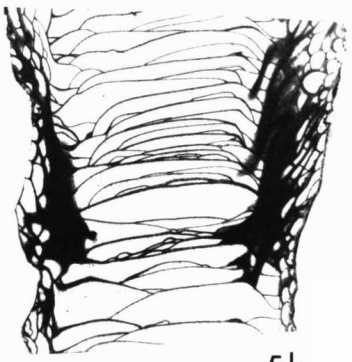
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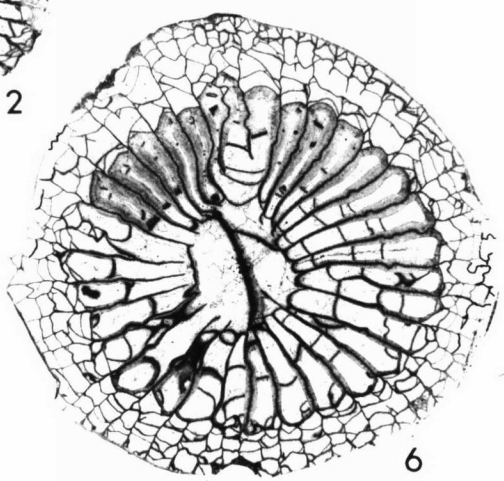
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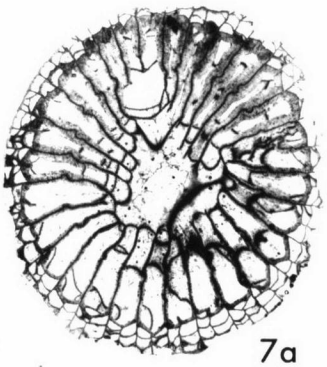
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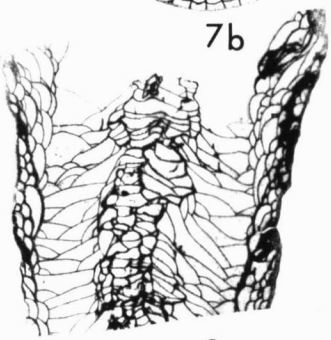
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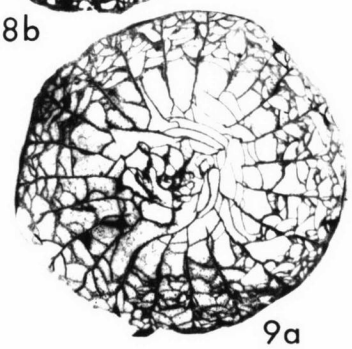
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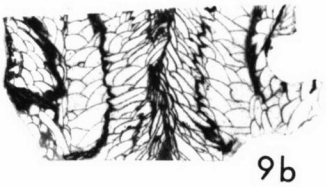
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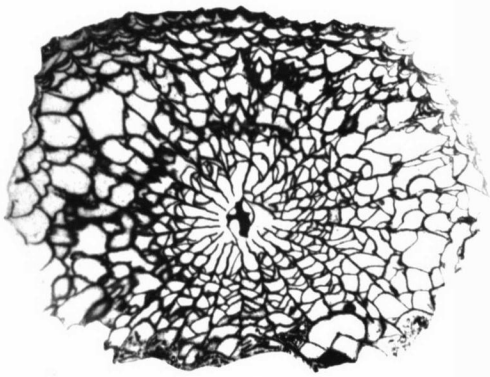

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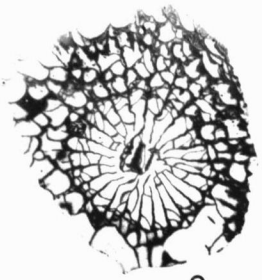

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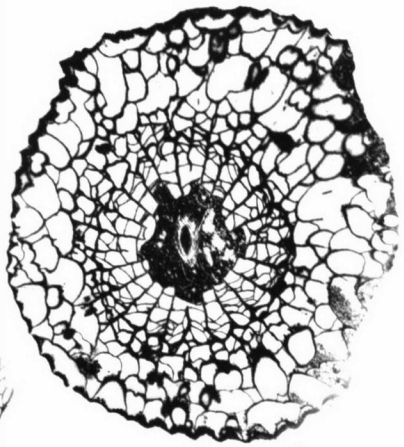

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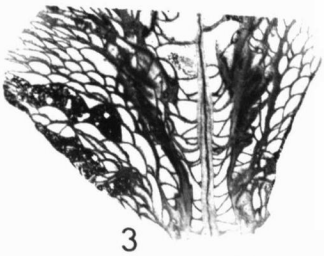

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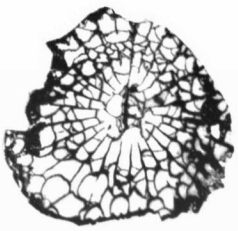

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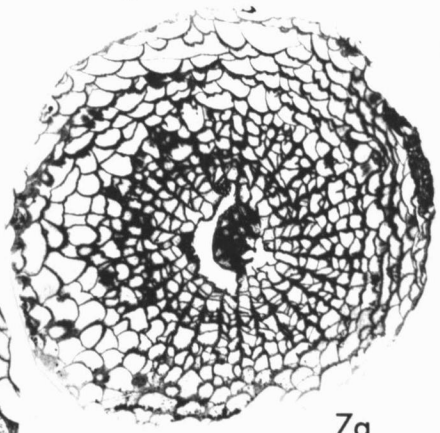

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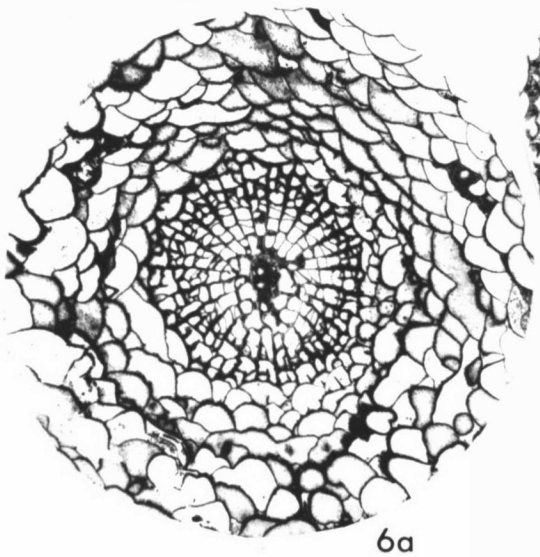

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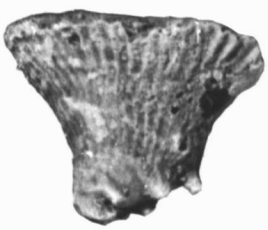

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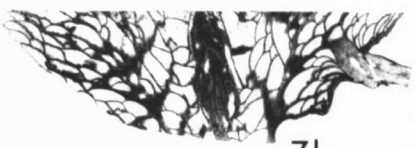

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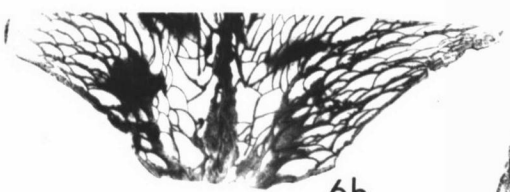

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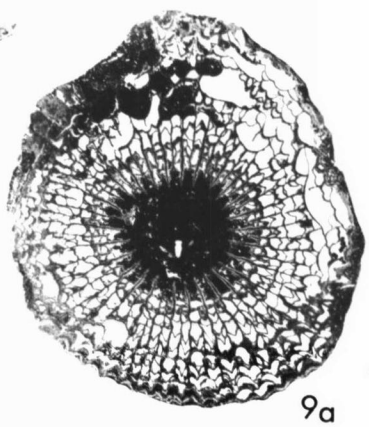

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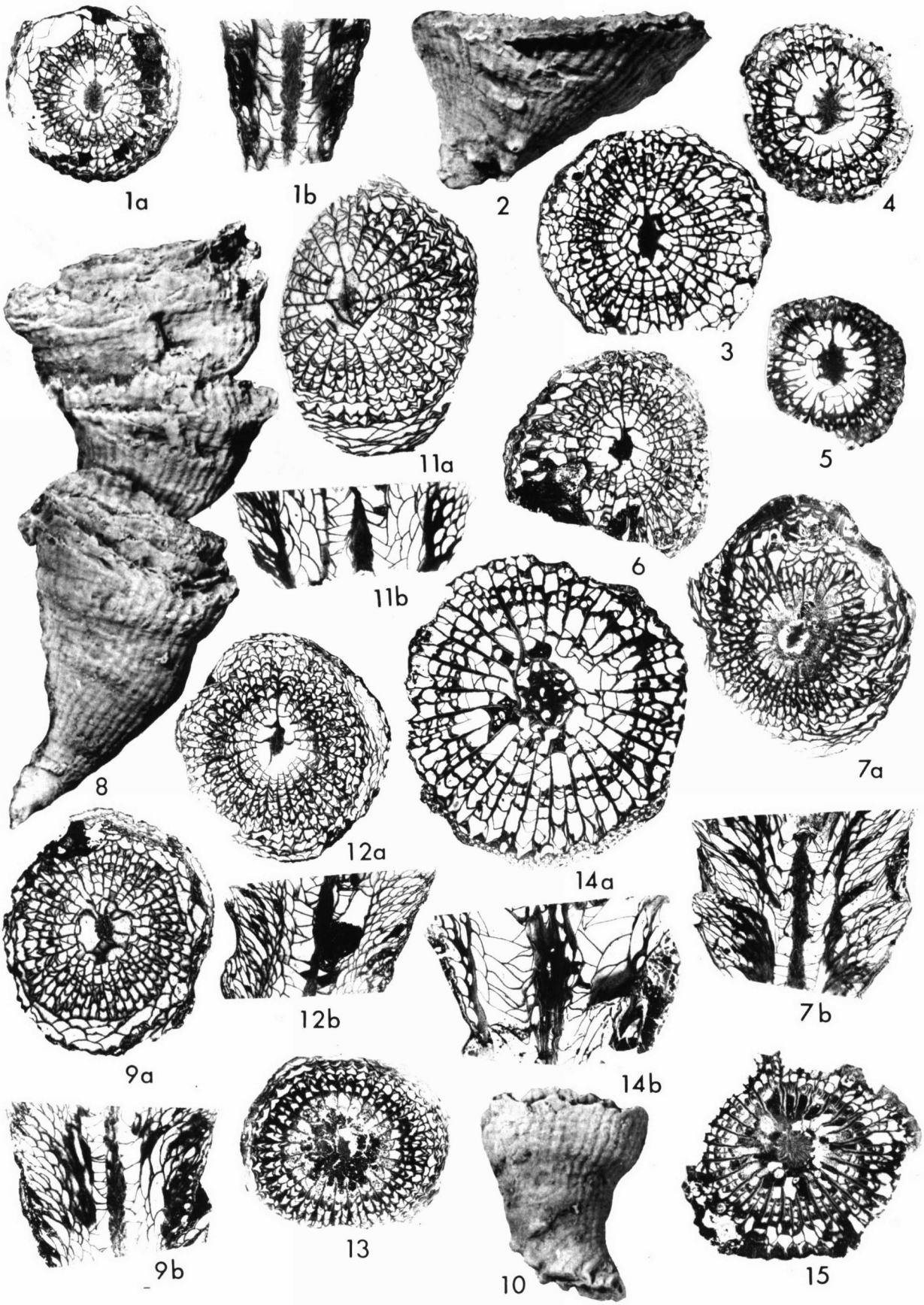
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